VOL. LIV.] ESTABLISHED BY EDWARD L. YOUMANS. [NO. 3.

Dup

APPLETONS' POPULAR SCIENCE MONTHLY.

JANUARY, 1899.

EDITED BY WILLIAM JAY YOUMANS.

CONTENTS.

NEW YORK:
D. APPLETON AND COMPANY,
72 FIFTH AVENUE.
SINGLE NUMBER, 50 CENTS. YEARLY SUBSCRIPTION, $5.00.

Entered at the Post Office at New York, and admitted for transmission through the mails at second-class rates.

Title: Appletons' Popular Science Monthly, January 1899
Volume LIV, No. 3, January 1899

Author: Various

Editor: William Jay Youmans

Release Date: November 2, 2013 [EBook #44097]

Language: English

Produced by Judith Wirawan, Greg Bergquist, and the Online
Distributed Proofreading Team at http://www.pgdp.net (This
file was produced from images generously made available
by Biodiversity Heritage Library.)

Established by Edward L. Youmans

APPLETONS' POPULAR SCIENCE MONTHLY

EDITED BY

WILLIAM JAY YOUMANS

VOL. LIV

NOVEMBER, 1898, TO APRIL, 1899

NEW YORK
D. APPLETON AND COMPANY
1899

VOL. LIV. ESTABLISHED BY EDWARD L. YOUMANS. NO. 3.

APPLETONS' POPULAR SCIENCE MONTHLY.

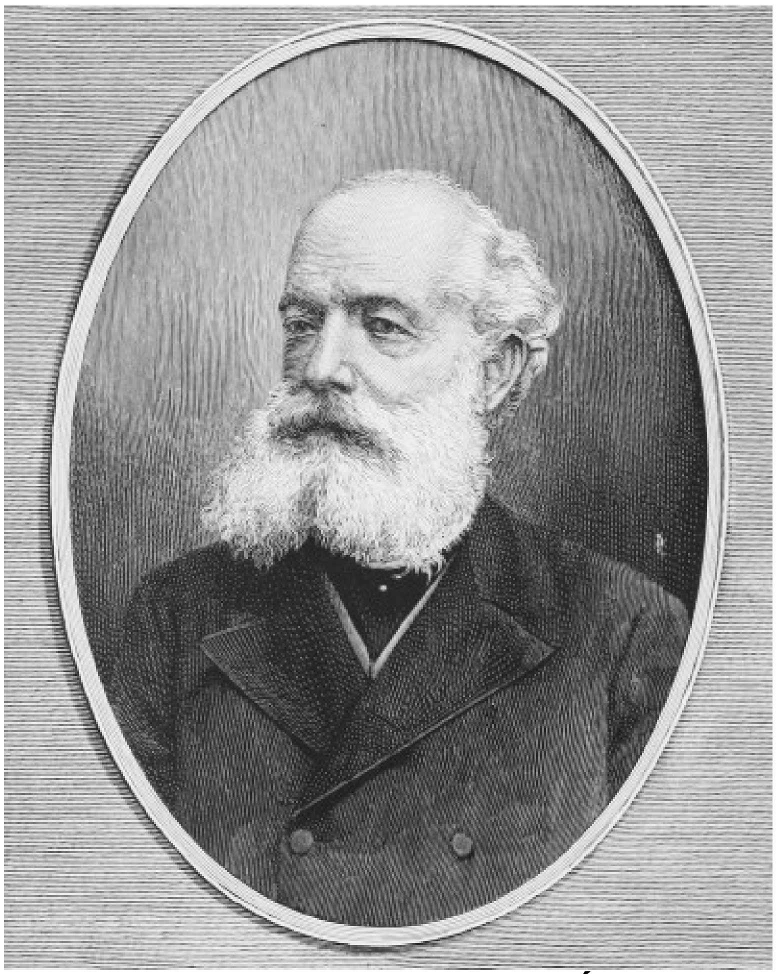
JANUARY, 1899.

EDITED BY WILLIAM JAY YOUMANS.

CONTENTS.

NEW YORK:
D. APPLETON AND COMPANY,
72 FIFTH AVENUE.

Single Number, 50 Cents. Yearly Subscription, $5.00.



AUGUST VON KEKULÉ.

APPLETONS' POPULAR SCIENCE MONTHLY.

JANUARY, 1899.

THE EVOLUTION OF COLONIES.

By JAMES COLLIER.

VI.—INDUSTRIAL EVOLUTION.

The earliest nomadic stage of mankind has left traces in many of the colonies. The first age of French Canada, of New York, of great part of North America, was one of hunters and trappers, and it has continued in the Northwest till recent times. The first brief period of Rhodesia was that of the big-game hunter. The Boers of the Transvaal are still as much hunters as farmers. The American backwoodsman who clears a patch, then sells his improvements to the first newcomer, and, placing his wife and children and scanty belongings on a cart, proceeds *da capo* elsewhere, is a nomadic pioneer. The stage is in one way or another perpetual, for the class never quite dies out. The drunken English quarryman who, driven by a demon of restlessness, continually goes "on tramp," and in his wanderings covers on foot a space equal to twice the circumference of the globe, is a demi-savage whose nomadism is only checked by the "abhorred approaches of old age." If he emigrates, he repeats the old, wild life as a pick-and-shovel man in Queensland or a quarryman in New South Wales. The soberer colonial youth, who more luxuriously canters from farm to farm in New Zealand on the back of a scrub, is a tamer specimen who settles down when he marries. Nay, the "restless man" who periodically applies for leave of absence from a colonial legislature in order to travel in India, China, and Timbuctoo, is a still milder but not less incorrigible example of the same indestructible type.

The pastoral stage is all but universal. Wherever grass grows (and there is wild grass almost everywhere) sheep can graze, and where there are succulent twigs cattle will fatten on them. The South American *estancias* and the ranches of Colorado, the cattle runs of Queensland and northern New Zealand, the sheep runs of Victoria and New South Wales repeat and perpetuate this stage. The genesis of it may even now be daily observed. A Manchester accountant who has never before been astride a horse will in twelve months learn the mysteries of cattle and sheep farming, then purchase a hundred acres or two from the colonial Government, gradually clear it of timber, build of his own trees, with no skilled assistance, a weatherboard cottage, and take home a swiftly wooed wife to lead

with him a rather desolate existence in "the bush." Or (on a larger scale) a squatter,[1] who is commonly a gentleman by birth and education, comes out from England with inherited wealth, buys or leases from the Government a large inland tract of grazing land, takes with him flocks and herds, shepherds and stockmen, builds a bark or wooden manor house, and settles down to the life of Abram on the plains of Mamre. In earlier days, when the colony was in its infancy, he would not have had to purchase or lease his "run." One country after another saw the golden age of a would-be landed aristocracy. As Norman William parceled out all England among his nobles and knights, rulers of conquered countries were then mighty free with what did not belong to them. Possessing the authority of a sovereign, Columbus made lavish grants of land, and thus pacified his rebels. Charles II presented Carolina to eight proprietors. Baronies of twelve thousand acres in South Carolina, manors of twenty thousand acres in Maryland, were dwarfed by territorial principalities of more than a million acres in New York. The absolute governors of early Australia gave away wide tracts. When land was not given it was taken, on Rob Roy's principle. During the interregnum that followed the recall of the first Governor of New South Wales, military robbers seized fifteen thousand acres, and under subsequent administrations they continued their depredations. Land was held on various tenures. The first American forms were varieties of belated feudalism; of a hundred often strange and ridiculous emblems of suzerainty perhaps a dozen repeated Old World customs.[2] Sir H. S. Maine has proved that nearly all the feudal exactions that maddened a whole people to mutiny in 1789 were then in force in England. How shadowy they must have grown is shown by the fact that none of them was transported to Botany Bay in that or later years. They were atrophied portions of the British land system when Australia was founded in 1788. For fully sixteen years the possession of lands granted or seized was as absolute as the English law ever allows it to be. Then the landholders, finding the large tracts already conceded insufficient for the development of the pastoral industry, applied for more, and themselves suggested in 1803 a plan of leasing crown lands which in the following year was legalized as "the first charter of squatterdom"; it was the beginning of a system that has brought under pastoral occupancy territories as extensive as the largest European countries. The land system formed part of or gave birth to a political organization. A host of so-called *seigneurs* imported into old Canada as much of the *ancien régime* as would bear the voyage. Manors in Maryland reproduced the feudal courts-baron and courts-leet. The great New York landowners, as inheriting both English and Dutch institutions, presided in such courts and were at the same time hereditary

members of a powerful legislative order.[3] The courts were dropped on the way out to Australia, but the political influence of the English landed aristocracy inhered in their representatives at the antipodes. As the Southern slavearchy, through its Washingtons and Jeffersons, Clays and Calhouns, was for three quarters of a century the driving force in American politics, the Australian squatterarchy for one generation or more ruled the seven colonies with a sway that waxed as the absolute power of the governor waned. It composed the legislature, appointed the judges, controlled the executive, and if the governor was refractory it sent him home. In both southern countries social life reflected its tastes and was the measure of its grandeur. It constituted "society," ran the races, gave the balls, and kept open house; the surrounding villages lived in its sunshine. Why could not this patriarchal state last, as it has lasted in Arabia for thousands of years and in Europe for centuries? In the Southern States it was brought to bankruptcy by the civil war. In Australia it collapsed before two enemies as deadly—a succession of droughts and a fall in the price of wool. The banker has his foot on the squatter's neck. If one may judge from the published maps, three fourths of the freehold land in the older colonies is in the hands of the money lenders. The once lordly runholder, who would have excluded from his table, or at least from his visiting circle, any one engaged in commerce, is now the tenant of a mortgage company which began by using him too well and ended by crushing him unmercifully.

It is also brought to a close by the rise of the agricultural stage. The colonial *latifundia* gets broken up for the same economic reasons as that of the mother country. Whenever from the increase of population wheat-growing becomes more profitable than grazing, land rises in value, and vast sheep walks are subdivided into two-hundred-acre farms, which are put under the plow. The transition may be retarded in some countries and altogether arrested in others. Nasse has shown that, in consequence of the moisture of the climate, there was in the sixteenth century a continual tendency in England to revert from agriculture to pasture. The light rainfall, high temperatures, and unfertilized soil will forever keep nine tenths of Australia under grass. Most of the mountainous north and the glacier-shaved portions of the south of New Zealand must be perpetual cattle runs and sheep walks. A century or perhaps centuries will pass before much of the light soil of Tasmania, hardly enriched by the scanty foliage of the eucalyptus, is sufficiently fertilized by grazing to grow corn. Rich alluvial or volcanic lands are put under the plow, without passing through the pastoral stage, as soon as markets are created by the advent of immigrants. There is a cry for farm lands. Companies that have bought large estates break them up into

allotments. When they or other large landholders still resist pressure, the radical colonial legislature accelerates their deliberations by putting on the thumbscrew of a statute which confiscates huge cantles of their land. Or the colonial Government, if socialist-democratic, purchases extensive properties, which it breaks up into farms and communistic village settlements. Over wide tracts the agriculturist, great and small, takes the place of the pastoralist. He holds his lands under a variety of tenures. New South Wales, in its search for an ideal form, has flowered into fifteen varieties. Other colonies are stumbling toward it more or less blindly through a succession of annual statutes. Where land is abundant the tenure will be easy. In North America nominal quitrents were general; the system was long since introduced into South Africa, and it has lately been imported into New Zealand in spite of all previous experience to the effect that such rents can not be collected. Mr. Eggleston remarks that in the United States the tendency was to "a simple and direct ownership of the soil by the occupant." Since those days Henry George has come and (alas!) gone. A craze for the nationalization of the land buzzes in the bonnets of all who have no land. There is an equal reluctance on the part of colonial legislatures to grant waste lands as freeholds and on the part of purchasers to accept them on any other terms. Hence the constant effort to devise a tenure which shall reserve the rights of the colony and yet not oppress the tenant. One legislature has blasphemed into the "eternal lease," which would seem to be almost preferable to absolute ownership in a country subject to earthquakes! But the tenure in the early days is unimportant. With a virgin soil yielding at first seventy and then regularly forty bushels to the acre, and high prices ruling, the farmer can stand any tenure. Seen at market or cattle show, his equine or bovine features and firm footing on mother earth suggest a sense of solidity in the commonwealth to which he belongs. He gives it its character. The legislature consists of his representatives. Laws are passed in his interest. He controls the executive. His sons fill the civil service. Judges sometimes come from his ranks, and lawyers easily fall back into them. He supports the churches and fills them. Small towns spring up in place of the pastoral villages to supply his wants. As the period of the Golden Fleece was the colonial age of gold, when Jason, the wool king, made a fortune, received a baronetcy, and, returning to the mother country, founded a county family and intermarried with the British aristocracy, so the agricultural stage is the colonial age of silver, in money as in morals. It lasted in England till well into the century, in Germany till the other day, in France till now. It is, in the main, the stage of contemporary colonies. What brings *it* to an end? The soil gets exhausted, prices fall, and a succession of wet seasons in New Zealand or of dry seasons in Australia or South Africa sends the farmer into the money market.

Nearly every province of almost every colony gets mortgaged up to the hilt. The foot of the land agent is on the neck of the farmer, who becomes his tenant or serf—*adscriptus glebæ* as much as the Old English villeins who were the ancestors of the farmer, or the Virginia villeins who repeated in the seventeenth century the Old English status. But tenancy does not always arise out of bankrupt proprietorship. A capitalist may drain an extensive marsh (like that along the valley of the Shoalhaven River in New South Wales) and divide the rich alluvial soil into hundreds of profitable dairy farms. More inland marshes, like the Piako Swamp in New Zealand, have been so completely drained as to make the soil too dry to carry wheat, and so have swamped both capitalists and banker. Where the squatter owner keeps the land in his own hands, he may lease an unbroken-up tract for three or five years to a farmer who plows and fences it, takes off crops, pays a light rent of from five to fifteen bushels per acre, and leaves it in grass. On one tenure or another the whole colony gradually comes into cultivation.

The predominance of the agricultural interest is long threatened and at length shaken by the rise of the industrial stage. It is partly evolved from the pastoral and agricultural stages and partly independent. Nor do these stages at once and necessarily give rise to collective industry. In all young colonies where the population is scanty and processes are simple there are no division and no association of labor. The account that one of the best of American historians gives of the Northwest Territory might be accepted as a description of this primitive state, and realizes Fichte's ideal of a *geschlossener Handelstaat* (closed trade state). Shut in by mountains, the people raised their own flax and sometimes grew their own wool, which they spun and wove at home. They made their own spinning wheels and looms, as they made their own furniture. They tanned their own leather and cobbled rude shoes of it. Of Indian-corn husks they spun ropes and manufactured horse collars and chair bottoms. Barrels and beehives were formed of sawn hollow trees. They extracted sugar from the maple and tea from the sassafras root. Their boats were dug-out canoes. In colonies of later foundation this self-sufficing stage, which repeats an earlier period in the mother country than the time when the colony was given off, is dropped, though there are traces of it everywhere to be found. Sheep countries give birth to the woolen industry. New Zealand reduplicates the woolen manufactures of England and, owing to protective duties, has attained a deserved success. New South Wales, with finer wools, has not succeeded, for no other apparent reason than that she refuses to impose such duties. For it is to be observed that it is under legislative protection—bounties, bonuses, drawbacks,

export and especially import duties—that almost every colonial industry has grown up, as the industries of the mother country grew up. Sometimes the profit in a particular undertaking is exactly equal to the amount of the import duty, and it is seldom greater. By taking extravagant advantage of the liberty long refused (as leave to manufacture was long refused to the North American colonies), but at length conceded, to impose import duties, an Australasian colony, misled as much by its own splendid energy as by evil counselors (Carlyle among them), built up a whole artificial system of industries which sank in ruinous collapse when the boom had passed. Independent industries spring first from the soil. Gold and silver mining lose their wild adventurous character, and become regular industries, worked by companies with extensive plants. The digging of gum in Auckland (bled from the gigantic Kauri pine) is operated by merchants who keep the gum diggers in a species of serfage. The discovery of coal makes native industries possible or remunerative, but till iron has been found the system is incomplete. All countries, and therefore all colonies, are late in reaching this stage; the most advanced contemporary colonies have not yet reached it. None the less have they followed England with swifter steps, if with less momentum, into the modern age of iron—that Brummagem epoch which has the creation of markets for its war cry, state socialism for its gospel, Joseph of Birmingham for its prophet, and the British Empire for its deity.

The iron age is fitly inaugurated by the most degraded relationship that man can bear to man—that of slavery. Only the oldest of modern colonies imitate the mother countries in passing through this stage; in those of later foundation a mere shadow of it remains, or it takes other shapes. Colonists first enslave the natives of the country where they settle. In the South American colonies, where they went to find gold, they would work for no other purpose; they therefore needed the natives to till the soil; they needed them also as carriers. For these purposes they were used unscrupulously. They were distributed among the Spaniards under a system of *repartimientos* which repeated the provisions of Greek and Roman slavery, and was itself reduplicated three centuries later in the convict assignment system of New South Wales. With such savage cruelty was it worked that, according to the testimony of Columbus, six sevenths of the population of Hispaniola died under it in a few years. The same form of slavery, but of a very different character, prevailed in Africa down almost to our own times. In the British colonies it was submerged in 1834, from causes exterior to itself, by the humanitarian wave that wrecked the West Indies; in the French colonies it was abolished by the revolutionary government of 1848; in the Dutch colonies it possibly subsists to this day. Theoretically abolished or not, the

relationship between civilized whites and savage blacks must be everywhere a modified form of slavery; and a white colonization of the African tropics can only take place under conditions indistinguishable from a limited slavery. In colder or younger colonies, even if a more refined sentiment had permitted it, there could be no question of enslaving the fierce red Indians, the warlike Maoris, or the intractable Australian blacks. The Indians rendered some services to the northern colonists. The Maoris worked for the first immigrants into Canterbury, but as free laborers, and the phase soon passed away as more valuable labor arrived. Blacks were in the early years employed by the Australian settlers, but like nearly all savages they were found incapable of continuous industry. The next step is to import slaves. To lighten the oppression of the Mexicans, negroes were introduced, as they had previously been into Europe. There, and still more in the southern colonies of North America, they were the chief pioneers. They cut down forests, cleared the jungles, drained the swamps, and opened up the country. For the best part of two hundred years the world's sugar, rice, cotton, tobacco, and indigo were grown by negro labor. The effect on the negro himself has been to raise him one grade in the scale of being. If, as Mr. Galton believes, he is naturally two grades below the European, a place in the "organization of labor" will have to be found for him midway between the white workman and the slave. It is, indeed, being found. As a farmer the negro has totally failed. "But he is a good laborer under supervision. He is a success in the mines. He has found acceptance in the iron furnaces and about the coke ovens. He is in great demand in periods of railroad construction," and he is a Western pioneer. Above born and bred slaves for life there is the status of imported slaves for a term. For years Kanakas, hired or captured from the Melanesian Islands of the Pacific, were used as slaves by the sugar planters of Queensland, until the outcry in England put a stop to an ill-conducted traffic. It has since been resumed under humaner conditions, which make it as defensible as slavery can ever be. Coolies from India are imported into Fiji and Hongkong practically as free laborers. They are also employed on board the great liners that ply between India, China, Australia, and England, much to the discontent of the working class and to the great satisfaction of the well-to-do, who thus gain cheaper passages and lower freights. The radical opposition is no more likely to prevent this form of native labor from spreading to all suitable environments than the conservative opposition has prevented women from filling the employments within their improved capacities. The ubiquitous Chinaman, again, has imported himself into most colonies, and so long as he takes a place that the white laborer refuses to occupy, he will present the ugly problem of the coexistence of an indestructible alien race with a civilized people whose type of

civilization and his are irreconcilable.

European colonies have also known white slavery, as Greek and Roman colonies knew it, and slavery of their own race and nation, as European countries knew it. Its most degraded type has doubtless been Spanish, English, and French convictism. The Australian-English is the most familiar and the worst. The Australian convict was a slave for life or a long term. Like the slave, he was at the mercy of his master, excepting that corporal punishment could not be inflicted by the master's hands. The lash was none the less kept going; in a single year, in New South Wales, nearly three thousand floggings were administered. The Roman *ergastula* were pleasure bowers compared with the convict hells of Parramatta, in New South Wales, and Port Arthur, in Tasmania. Marcus Clarke's terrible fiction proves to be still more terrible fact. Convicts were herded together like pigs; kindness was rare, oppression general, and many fine men died inch by inch. Such was the state of things even after the introduction of the assignment system. According to that system, convicts were assigned as agricultural laborers and shepherds to settlers who cried out for them, as the American planters did for slaves. Craftsmen were allotted to high officials in lieu of salary or to influential persons who hired them to others (herein repeating English serfdom) or permitted them to work for themselves, receiving a portion of their earnings (herein repeating Greek slavery). Mechanics were employed on public works, and hundreds of buildings were erected by convict masons, bricklayers, and carpenters. Day laborers were employed on roads, and hundreds of miles of solid highway are a durable monument to the memory of the convict. They were the true pioneers of the country, braving the dangers of the "bush," resisting the aborigines, clearing and cultivating the land, and developing the resources of the colonies. For themselves they did well and ill. Many reformed, and after manumission, which was at first special and at length general, became respectable citizens, dealers, and traders. Some grew to be prosperous merchants, wealthy squatters, editors, legislators, and all but ministers. Their sons are judges, legislators, solicitors, Government officials, newspaper proprietors. After lasting for sixty years the system of transportation was at length abolished in consequence of the opposition of the working class, who objected to competition, and of the respectable classes generally. The legislative body and the large landowners were rather in favor of its perpetuity, and there are still members of the old "slave-driving party" in Tasmania who regret its discontinuance.

The bond servants, who were common in New England and at first more

numerous than slaves in the Southern States, repeated the status of the English serfs. Their origin was various. Crime, debt, sale by parents, voluntary surrender, and kidnapping all contributed their quota. The period of indentured service was at first from seven to ten years, and was ultimately reduced to a fixed term of four years. They were exchanged and sold like any other commodity. Their treatment seems to have been often harsh. Like the Australian convicts, many of them prospered. Leading families in the United States trace their origin to bondmen. Not a few of the Southern overseers, free laborers, and small farmers are believed to be descended from them. The vagabond element in all the States, the "white trash" of the South, and the criminal and pauper inhabitants of certain regions in the North are also affiliated on the more degraded sections of the class.[4]

The worst of modern inventions, it has been said, is the invention of the workingman. The workingman, however, has a pedigree; he is the son of the bondman or the serf, and the grandson of the slave, who would have been still more discreditable "inventions" if they had not been the outgrowth of their time and place. The servile character of the workman long survived in European countries; it was not till the beginning of this century that the last trades were emancipated in England. While in North America and New South Wales the transition is plainly traceable, all vestiges of it have disappeared in the younger colonies. In these, almost from the first, the mechanic is master of the situation. The carpenter who can put up a wooden cottage commands regular work and high wages, while the preacher who builds him a house not made with hands is starved. The anomaly is in perfect consistency with the biological analogy; the brain is everywhere of late development. As the colony grows, wages fall, and the position of professional men becomes more tolerable, but, *en revanche*, the workman acquires and at length almost monopolizes political power. The premier and cabinet ministers are sometimes former peddlers, gold diggers, coal miners, shepherds, etc. The legislative bodies consist largely of labor representatives. Laws are passed in the interest of labor. Not content with a share of political power out of all proportion to their numbers or importance, the regimented trades, under the command of unscrupulous leaders, deliver a pitched battle against the employers, with the object of gaining practical possession of the agencies of production and distribution. They are necessarily defeated. The value of labor and the importance of the mechanic decline with the application of machinery to all industrial processes. Accumulated wealth, subsidizing inventions, acquires an increasing ascendency. The industrial system is in no greater danger from the onslaughts of labor than civilized countries from the

invasion of barbarians.

Only the beginnings of the commercial epoch, or age of bronze, are to be found in colonies. In production we witness the same supersession of individual enterprise by the limited liability company. This is also the case in distribution, where many obsolete Old World stages are recapitulated. We may still see the long, slow bullock team, the wearied pack horse (the fur trade in Canada was carried on by "brigades of pack horses"), the hawker, purveyor of news and gossip. We easily trace the evolution of the shop: at first a ship, then landed, with everything inside—groceries, meat, bread, fruit, and vegetables, clothes, crockery, ironmongery, stationery, and tobacco; the butcher first hives off, then the baker, the grocer; in course of time reintegration takes place, and shops are to be found in the colonial cities which reduplicate Whiteley's in London, where everything may again be had as in the beginning. The processes of exchange likewise recapitulate the past. Barter is long universal, and is still common in colonial villages. Even then a standard is needed. In the Old English period the "currency" consisted of cattle, named by a facetious writer "the current *kine* of the realm." In Virginia and Maryland tobacco was the circulating medium for a century and a half, supplemented in Maryland with hemp and flax; taxes were paid in tobacco, and rent in kind. In Illinois and Canada, skins and furs, with wampum for small coin; in New England the latter singular currency was used far into the eighteenth century. New South Wales has the demerit of inventing the destructive medium of rum; wages were paid in it or in wheat; meal or spirits were taken at the doors of theaters. Store receipts for produce were given by the Government and passed current, not without depreciation; military officers issued bills for all sums up to one hundred pounds; private individuals, in the lack of specie, gave promissory notes. Fixed prices were long unknown; extortioners in the early days of all the colonies made a profit of a thousand per cent; and in quite recent days usurious attorneys exacted interest at the rate of a hundred per cent.

Colonies sometimes anticipate the development of the mother country. The communistic dreams of the forties in France and England were for a brief while realized in old Virginia, as they are at this hour being realized in the village settlements of South Australia; and the state socialism rendered popular by the German victories of 1870 was perhaps more thoroughly embodied in convict New South Wales than anywhere else outside of Peru under the Incas, as it is now sweeping all of the Australasian colonies onward to an unknown goal.

THE MIND'S EYE.

By JOSEPH JASTROW.

> HAMLET.—My father,—Methinks, I see my father.
> HORATIO.—O, where, my lord?
> HAMLET.—In my mind's eye, Horatio.

It is a commonplace taught from nursery to university that we see with our eyes, hear with our ears, and feel with the fingers. This is the truth, but not the whole truth. Indispensable as are the sense organs in gaining an acquaintance with the world in which we live, yet they alone do not determine how extensive or how accurate that acquaintance shall be. There is a mind behind the eye and the ear and the finger tips which guides them in gathering information, and gives value and order to the exercise of the senses. This is particularly true of vision, the most intellectual of all the senses, the one in which mere acuteness of the sense organ counts least and the training in observation counts most. The eagle's eye sees farther, but our eyes tell us much more of what is seen.

The eye is often compared to a photographic camera, with its eyelid cap, its iris shutter, its lens, and its sensitive plate—the retina; when properly adjusted for distance and light, the image is formed on the retina as on the glass plate, and the picture is taken. So far the comparison is helpful; but while the camera takes a picture whenever and wherever the plate happens to be exposed, the complete act of seeing requires some co-operation on the part of the mind. The retina may be exposed a thousand times and take but few pictures; or perhaps it is better to say that the pictures may be taken, but remain undeveloped and evanescent. The pictures that are developed are stacked up, like the negatives in the photographer's shop, in the pigeonholes of our mental storerooms—some faded and blurred, some poorly arranged or mislaid, some often referred to and fresh prints made therefrom, and some quite neglected.

In order to see, it is at once necessary that the retina be suitably exposed toward the object to be seen, and that the mind be favorably disposed to the assimilation of the impression. True seeing, observing, is a double process, partly objective or outward—the thing seen and the retina—and partly subjective or inward—the picture mysteriously transferred to the mind's representative, the brain, and there

received and affiliated with other images. Illustrations of such seeing "with the mind's eye" are not far to seek. Wherever the beauties and conformations of natural scenery invite the eye of man does he discover familiar forms and faces (Fig. 1); the forces of Nature have rough-hewn the rocks, but the human eye detects and often creates the resemblances. The stranger to whom such curiosities of form are first pointed out often finds it difficult to discover the resemblance, but once seen the face or form obtrudes itself in every view and seems the most conspicuous feature in the outlook. The flickering fire furnishes a fine background for the activity of the mind's eye, and against this it projects the forms and fancies which the leaping flames and the burning embers from time to time suggest. Not all see these fire-pictures readily, for our mental eyes differ more from one another than the physical ones, and perhaps no two persons see the same picture in quite the same way. It is not quite true, however, as many have held, that in waking hours we all have a world in common, but in dreams each has a world of his own, for our waking worlds are made different by the differences in what engages our interest and our attention. It is true that our eyes when open are opened very largely to the same views, but by no one observer are all these views, though visible, really seen.

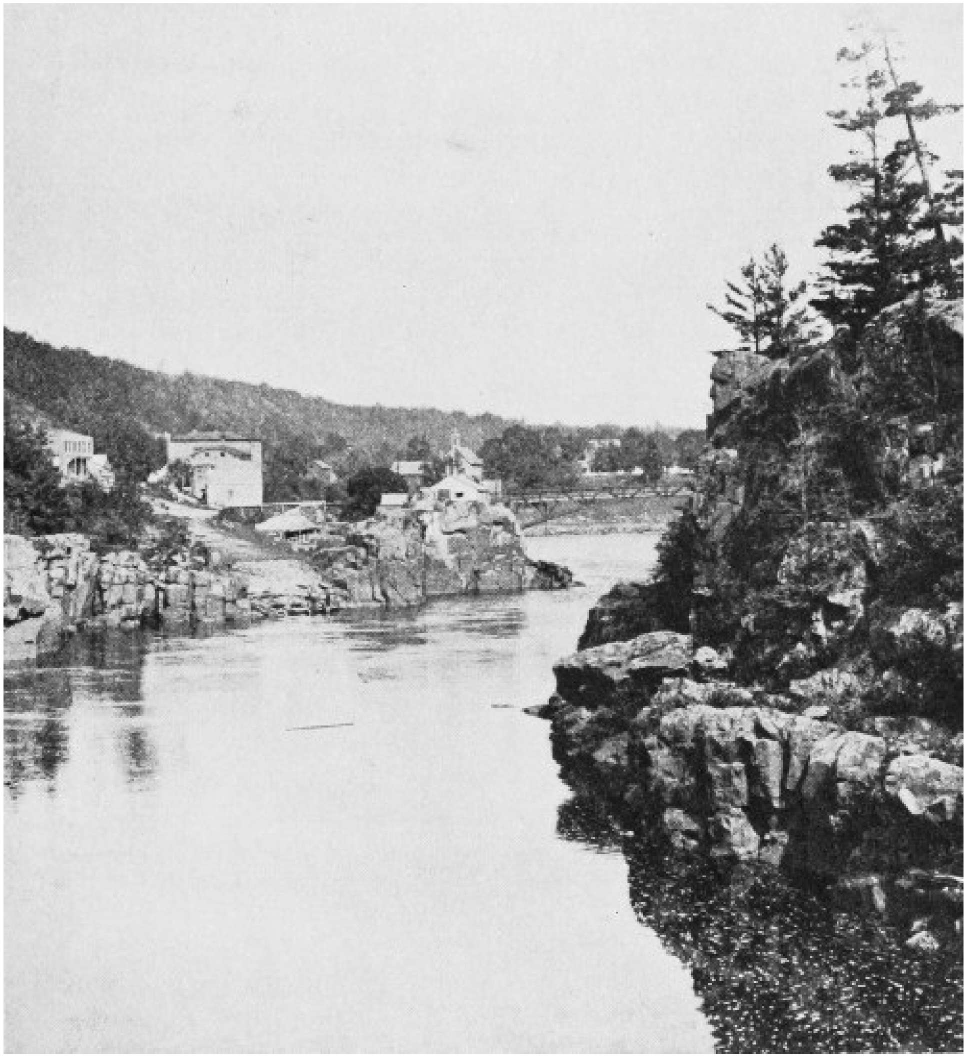


Fig. 1.[5] —The man's face in the rocks is quite distinct, and is usually readily found when it is known that there is a face somewhere. (For this view from the Dalles of the St. Croix, Minn., I am indebted to the courtesy of Mr. W. H. Dudley, of Madison, Wis.)

This characteristic of human vision often serves as a source of amusement. The puzzle picture with its tantalizing face, or animal, or what not, hidden in the trees, or fantastically constructed out of heterogeneous elements that make up the composition, is to many quite irresistible. We turn it about in all directions, wondering where the hidden form can be, scanning every detail of the picture, until suddenly a chance glimpse reveals it, plainly staring us in the face. When several persons are engaged in this occupation, it is amusing to observe how blind each is to what the others see; their physical eyes see alike, but their mental eyes reflect their own individualities.

Fig. 2.—In order to see the lion's head, hold the dollar exactly inverted and the head will be discovered facing the left, as above outlined. It is clearer on the dollar itself than in this reproduction.

Thousands upon thousands of persons handle our silver dollar, but few happen to observe the lion's head which lies concealed in the representation of the familiar head of Liberty; frequently even a careful examination fails to detect this hidden emblem of British rule; but, as before, when once found, it is quite obvious (Fig. 2). For similar reasons it is a great aid in looking for an object to know what to look for; to be readily found, the object, though lost to sight, should be to memory clear. Searching is a mental process similar to the matching of a piece of fabric in texture or color, when one has forgotten the sample and must rely upon the remembrance of its appearance. If the recollection is clear and distinct, recognition takes place when the judgment decides that what the physical eye sees corresponds to the image in the mind's eye; with an indistinct mental image the recognition becomes doubtful or faulty. The novice in the use of the microscope experiences considerable difficulty in observing the appearance which his instructor sees and describes, and this because his conception of the

object to be seen is lacking in precision. Hence his training in the use of the microscope is distinctly aided by consulting the illustrations in the text-book, for they enable his mental eye to realize the pictures which it should entertain. He may be altogether too much influenced by the pictures thus suggested to his mental vision, and draw what is really not under his microscope at all; much as the young arithmetician will manage to obtain the answer which the book requires even at the cost of a resort to very unmathematical processes. For training in correct and accurate vision it is necessary to acquire an alert mental eye that observes all that is objectively visible, but does not permit the subjective to add to or modify what is really present.

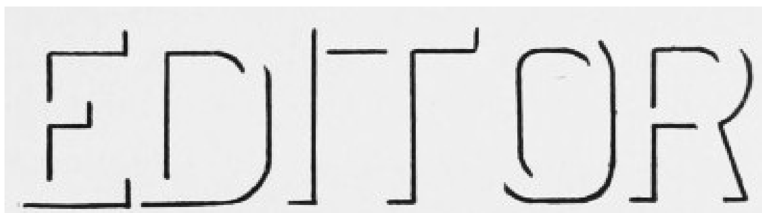


FIG. 3.—Observe the appearance of these letters at a distance of eight to twelve feet. An interesting method of testing the activity of the mind's eye with these letters is described in the text.

FIG. 3*a*. FIG. 3*b*.

FIGS. 3*a* and 3*b*.

The importance of the mind's eye in ordinary vision is also well illustrated in cases in which we see or seem to see what is not really present, but what for one cause or another it is natural to suppose is present. A very familiar instance of this process is the constant overlooking of misprints—false letters, transposed letters, and missing letters—unless these happen to be particularly striking. We see only the general physiognomy of the word and the detailed features are supplied from within; in this case it is the expected that happens. Reading is done largely by the mental eye; and entire words, obviously suggested by the context, are sometimes read in, when they have been accidentally omitted. This is more apt to occur with the irregular characters used in manuscript than in the more distinct forms of the printed alphabet, and is particularly frequent in reading over what one has himself written. In reading proof, however, we are eager to detect misprints, and this change in attitude helps to make them visible.

It is difficult to illustrate this process intentionally, because the knowledge that one's powers of observation are about to be tested places one on one's guard, and thus suppresses the natural activity of the mind's eye and draws unusual attention to objective details. Let the reader at this point hold the page at some distance off —say, eight or twelve feet—and draw an exact reproduction of the letters shown in Fig. 3. Let him not read further until this has been done, and *perhaps* he may find that he has introduced strokes which were not present in the original. If this is not the case, let him try the test upon those who are ignorant of its nature, and he will find that most persons will supply light lines to complete the contours of the letters which in the original are suggested but not really present; the original outline, Fig. 3*a*, becomes something like Fig. 3*b*, and so on for the rest of the letters. The physical eye sees the former, but the mental eye sees the latter.

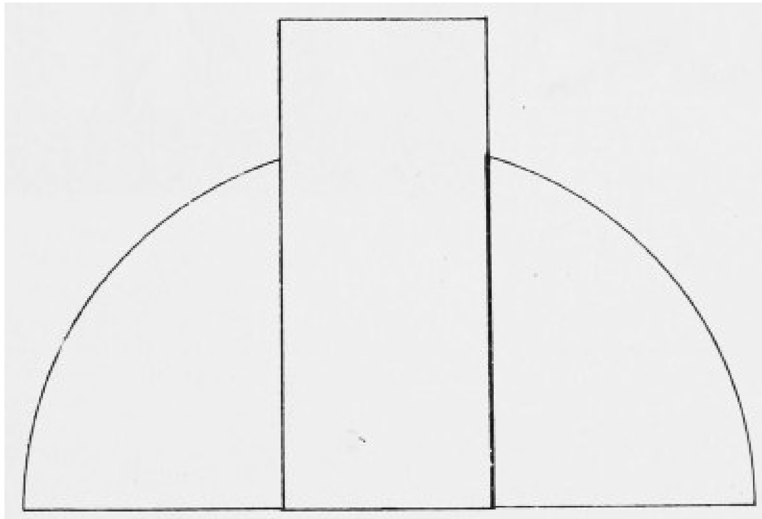


Fig. 4.—For description, see text.

I tried this experiment with a class of over thirty university students of Psychology, and, although they were disposed to be quite critical and suspected some kind of an illusion, only three or four drew the letters correctly; all the rest filled in the imaginary light contours; some even drew them as heavily as the real strokes. I followed this by an experiment of a similar character. I placed upon a table a figure (Fig. 4) made of light cardboard, fastened to blocks of wood at the base so that the pieces would easily stand upright. The middle piece, which is rectangular and high, was placed a little in front of the rest of the figure. The students were asked to describe precisely what they saw, and with one exception they all described, in different words, a semicircular piece of cardboard with a rectangular piece in front of it. In reality there was no half-circle of cardboard, but only parts of two quarter-circles. The students, of course, were well aware that their physical eyes could not see what was behind the middle cardboard, but they inferred that the two side pieces were parts of one continuous semicircle. This they saw, so far as they saw it at all, with their mind's eye.

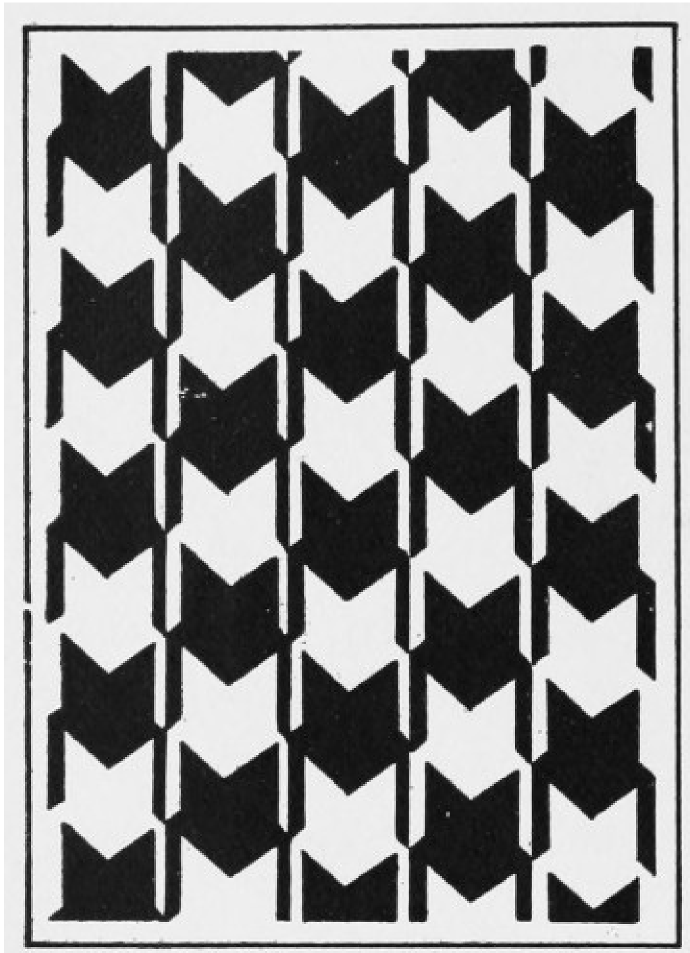


FIG. 5.—The black and white portions of this design are precisely alike, but the effect of looking at the figure as a pattern in black upon a white background, or as a pattern in white upon a black background, is quite different, although the difference is not easily described.

There is a further interesting class of illustrations in which a single outward impression changes its character according as it is viewed as representing one thing or another. In a general way we see the same thing all the time, and the image on the retina does not change. But as we shift the attention from one portion of the view to another, or as we view it with a different mental conception of what the figure represents, it assumes a different aspect, and to our mental eye becomes quite a different thing. A slight but interesting change takes place if we view Fig. 5 first with the conception that the black is the pattern to be seen and the white the background, and again try to see the white as the pattern against a black background. I give a further illustration of such a change in Fig. 6. In our first and natural view of this we focus the attention upon the black lines and observe the familiar illusion, that the four vertical lines seem far from

parallel. That they are parallel can be verified by measurement, or by covering up all of the diagram except the four main lines. But if the white part of the diagram is conceived as the design against a black background, then the design is no longer the same, and with this change the illusion appears, and the four lines seem parallel, as they really are. It may require a little effort to bring about this change, but it is very marked when once realised.

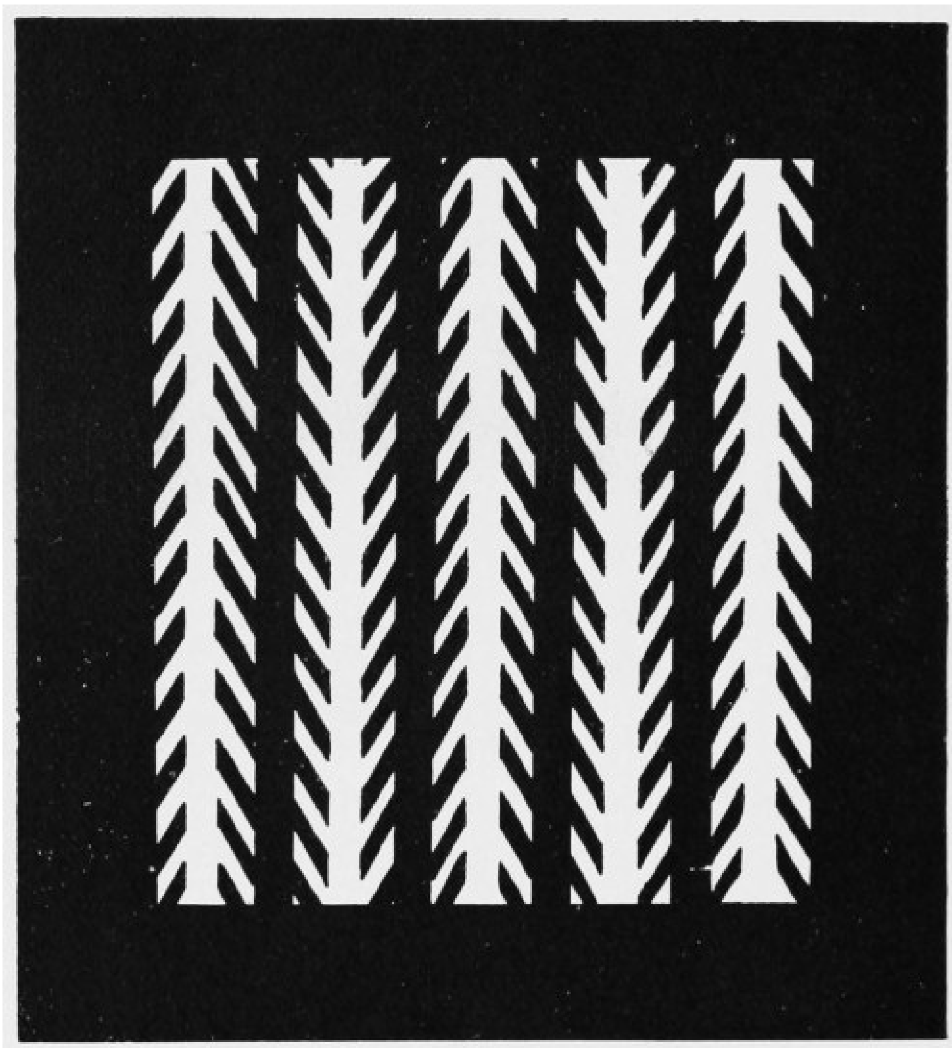


Fig. 6.—When this figure is viewed as a black pattern on a white background, the four main vertical lines seem far from parallel; when it is viewed as a white pattern on a black background this illusion disappears (or nearly so), and the black lines as well as the white ones seem parallel.

A curious optical effect which in part illustrates the change in appearance under different aspects is reproduced in Fig. 7. In this case the enchantment of distance is necessary to produce the transformation. Viewed at the usual reading distance, we see nothing but an irregular and meaningless assemblage of black and white

blotches. At a distance of fifteen to eighteen feet, however, a man's head appears quite clearly. Also observe that after the head has once been realized it becomes possible to obtain suggestions of it at nearer distances.

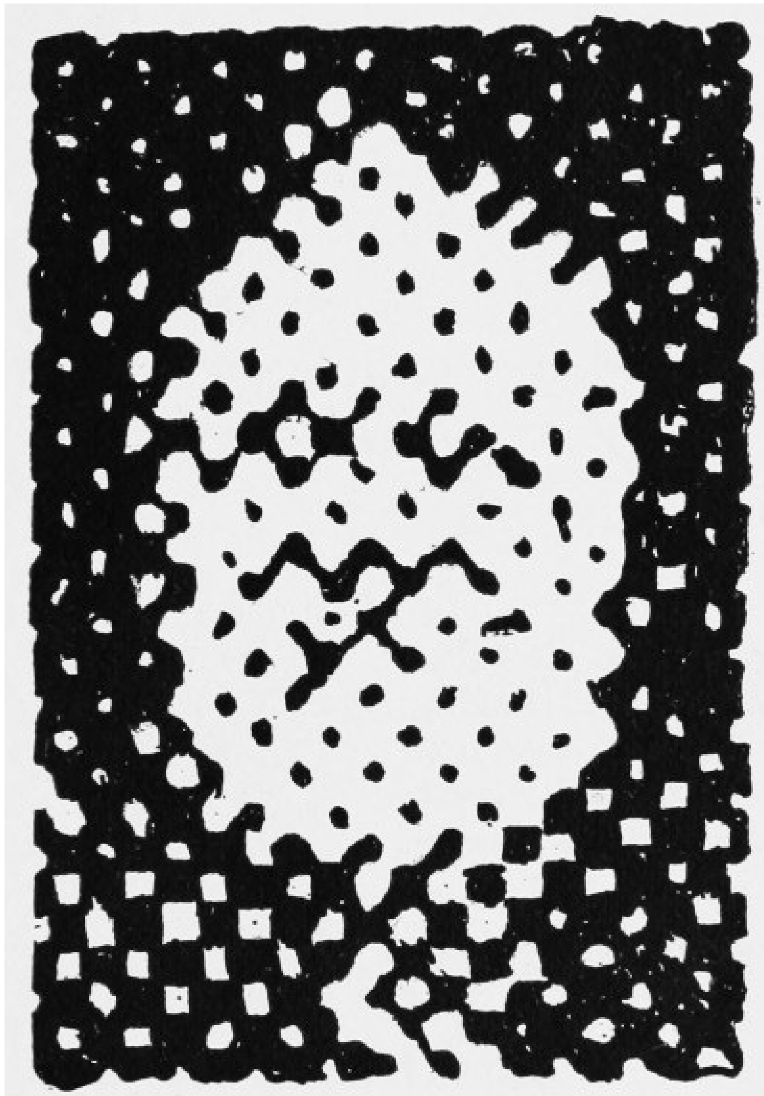


Fig. 7.—This is a highly enlarged reproduction taken from a half-tone process print of Lord Kelvin. It appeared in the Photographic Times.

A much larger class of ambiguous diagrams consists of those which represent by simple outlines familiar geometrical forms or objects. We cultivate such a use of our eyes, as indeed of all our faculties, as will on the whole lead to the most profitable results. As a rule, the particular impression is not so important as what it represents. Sense impressions are simply the symbols or signs of things or ideas, and the thing or the idea is more important than the sign. Accordingly, we are accustomed to interpret lines, whenever we can, as the representations of

objects. We are well aware that the canvas or the etching or the photograph before us is a flat surface in two dimensions, but we see the picture as the representation of solid objects in three dimensions. This is the illusion of pictorial art. So strong is this tendency to view lines as the symbols of things that if there is the slightest chance of so viewing them, we invariably do so; for we have a great deal of experience with things that present their contours as lines, and very little with mere lines or surfaces. If we view outlines only, without shading or perspective or anything to definitely suggest what is foreground and what background, it becomes possible for the mind to supply these details and see foreground as background, and *vice versa*.

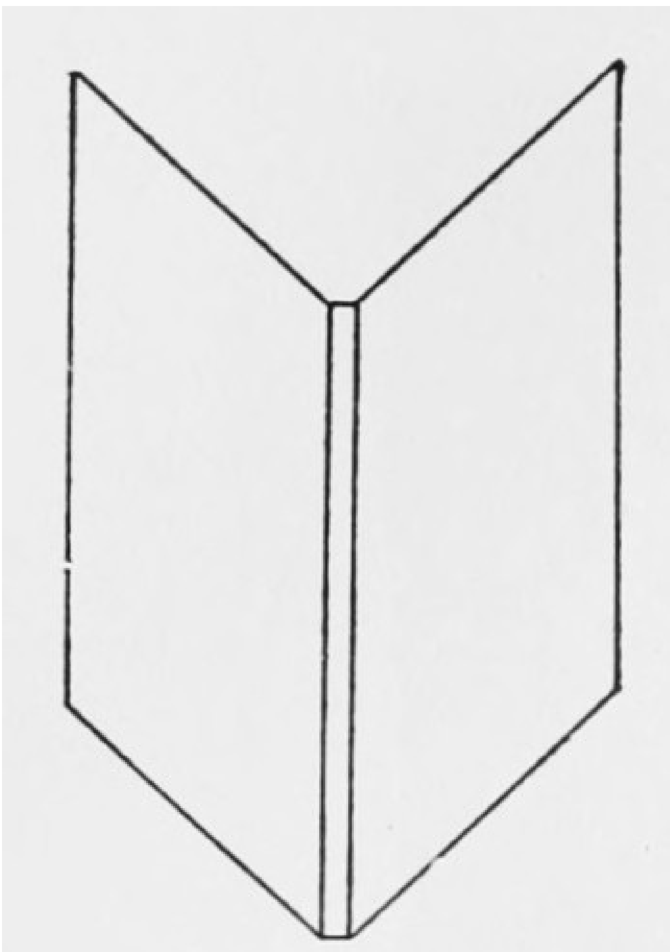


FIG. 8.—This drawing may be viewed as the representation of a book standing on its half-opened covers as seen from the back of the book; or as the inside view of an open book showing the pages.

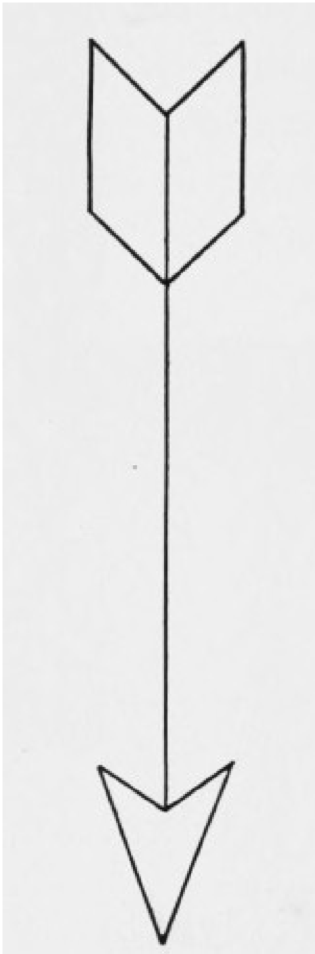


Fig. 9.—When this figure is viewed as an arrow, the upper or feathered end seems flat; when the rest of the arrow is covered, the feathered end may be made to project or recede like the book cover in Fig. 8.

A good example to begin with is Fig. 8. These outlines will probably suggest at first view a book, or better a book cover, seen with its back toward you and its sides sloping away from you; but it may also be viewed as a book opened out toward you and presenting to you an inside view of its contents. Should the change not come readily, it may be facilitated by thinking persistently of the appearance of an open book in this position. The upper portion of Fig. 9 is practically the same as Fig. 8, and if the rest of the figure be covered up, it will change as did the book cover; when, however, the whole figure is viewed as an arrow, a new conception enters, and the apparently solid book cover becomes the *flat* feathered part of the arrow. Look at the next figure (Fig. 10), which represents in outline a truncated pyramid with a square base. Is the smaller square nearer to you, and are the sides of the pyramid sloping away from you toward the larger square in the rear? Or are you looking into the hollow of a

truncated pyramid with the smaller square in the background? Or is it now one and now the other, according as you decide to see it? Here (Fig. 13) is a skeleton box which you may conceive as made of wires outlining the sides. Now the front, or side nearest to me, seems directed downward and to the left; again, it has shifted its position and is no longer the front, and the side which appears to be the front seems directed upward and to the right. The presence of the diagonal line makes the change more striking: in one position it runs from the left-hand *rear* upper corner to the right-hand *front* lower corner; while in the other it connects the left-hand *front* upper corner with the right-hand *rear* lower corner.

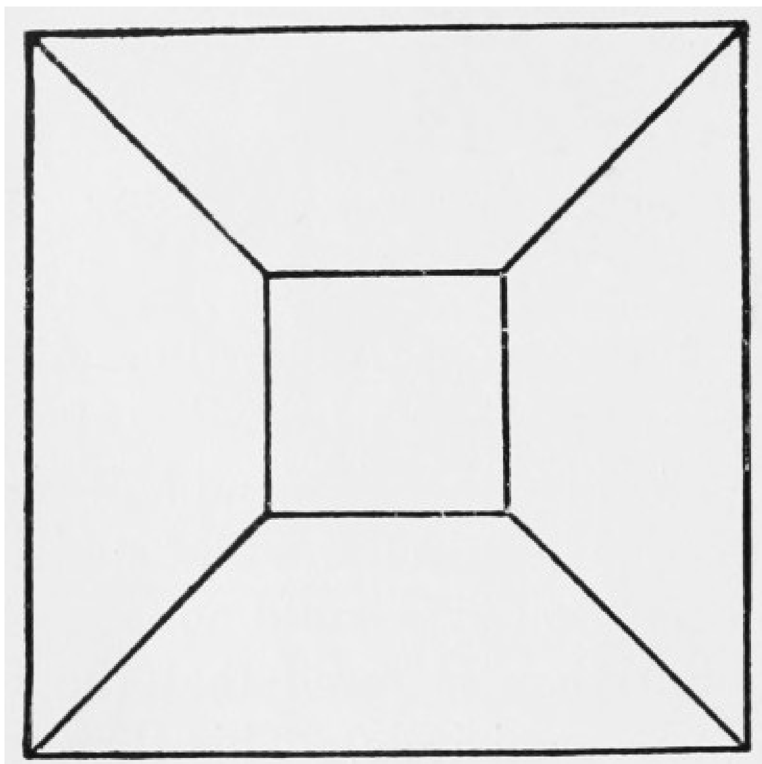


FIG. 10.—The smaller square may be regarded as either the nearer face of a projecting figure or as the more distant face of a hollow figure.

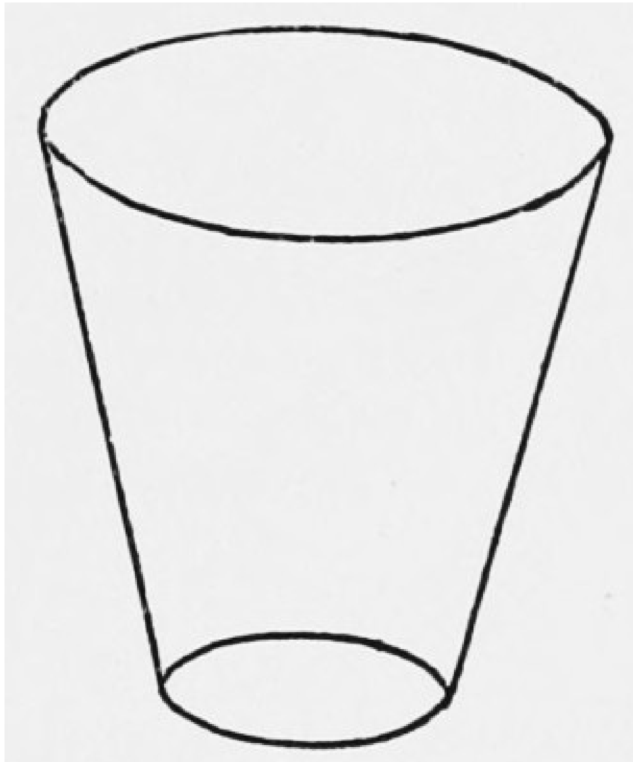


FIG. 11.—This represents an ordinary table-glass, the bottom of the glass and the entire rear side, except the upper portion, being seen through the transparent nearer side, and the rear apparently projecting above the front. But it fluctuates in appearance between this and a view of the glass in which the bottom is seen directly, partly from underneath, the *whole* of the rear side is seen through the transparent front, and the front projects above the back.

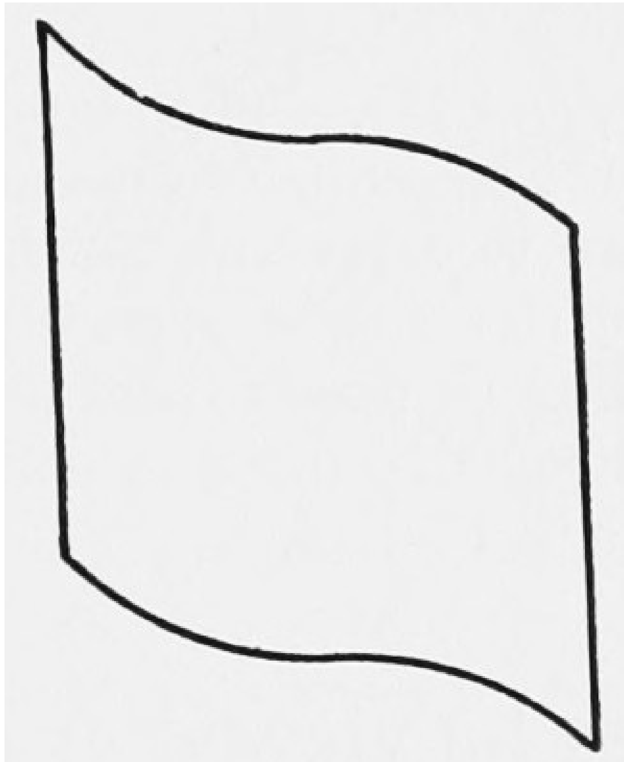
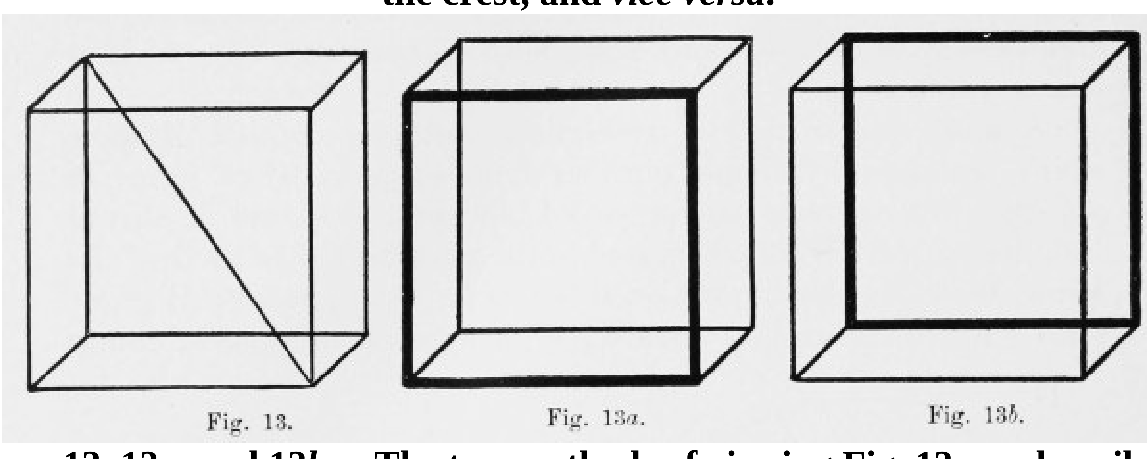


Fig. 12.—In this scroll the left half may at first seem concave and the right convex, it then seems to roll or advance like a wave, and the left seems convex and the right concave, as though the trough of the wave had become the crest, and *vice versa*.



Figs. 13, 13*a*, and 13*b*.—The two methods of viewing Fig. 13 are described in the text. Figs. 13*a* and 13*b* are added to make clearer the two methods of viewing Fig. 13. The heavier lines seem to represent the nearer surface. Fig. 13*a* more naturally suggests the nearer surface of the box in a position downward and to the left, and Fig. 13*b* makes the nearer side seem to be upward and to the right. But in spite of the heavier outlines of the one surface, it may be made to shift positions from foreground to background, although not so readily as in Fig. 13.

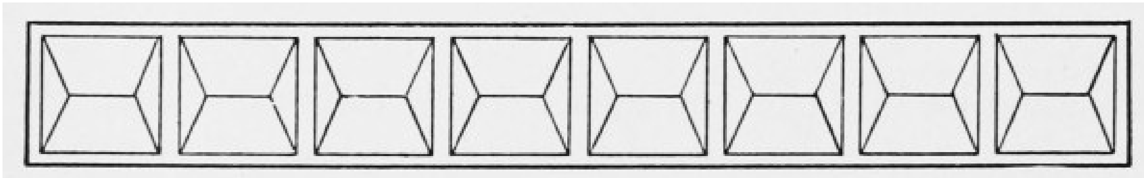
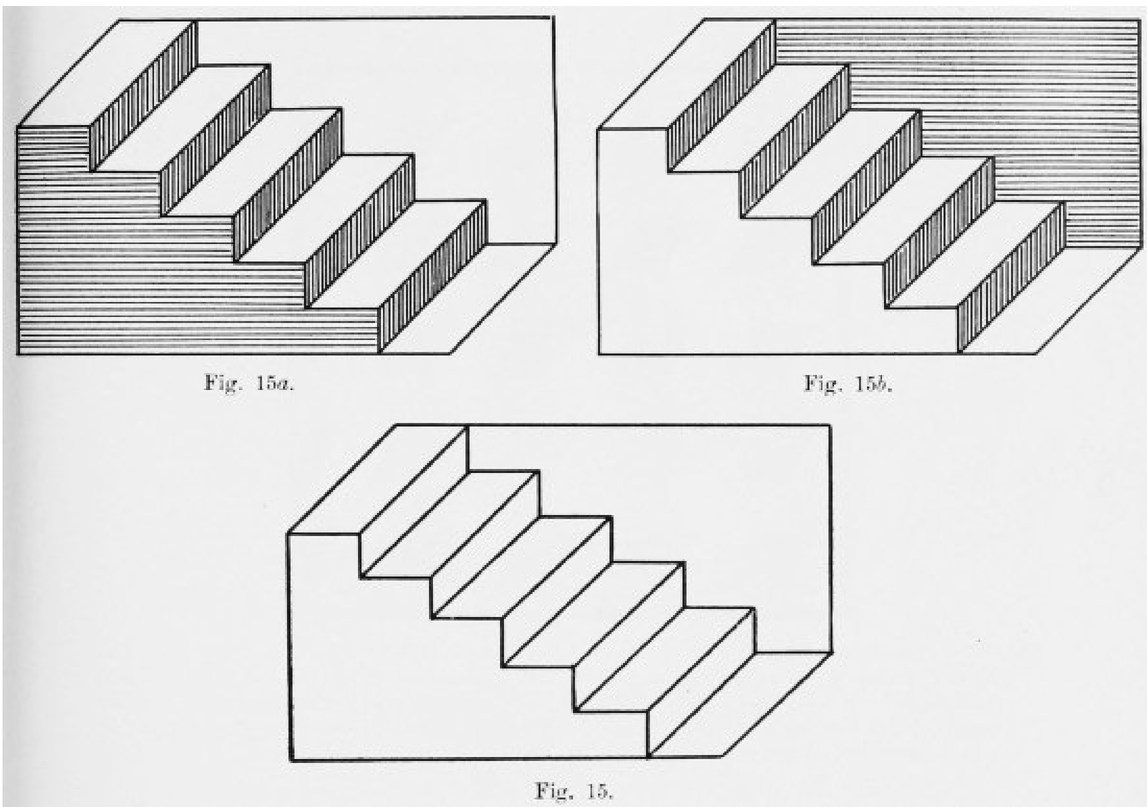


Fig. 14.—Each member of this frieze represents a relief ornament, applied upon the background, which in cross-section would be an isosceles triangle with a large obtuse angle, or a space of similar shape hollowed out of the solid wood or stone. In running the eye along the pattern, it is interesting to observe how variously the patterns fluctuate from one of these aspects to the other.



Figs. 15, 15*a*, and 15*b*.—The two views of Fig. 15 described in the text are brought out more clearly in Figs. 15*a* and 15*b*. The shaded portion tends to be regarded as the nearer face. Fig. 15*a* is more apt to suggest the steps seen as we ascend them. Fig. 15*b* seems to represent the hollowed-out structure underneath the steps. But even with the shading the dual interpretation is possible, although less obvious.

Fig. 15 will probably seen at first glimpse to be the view of a flight of steps which one is about to ascend from right to left. Imagine it, however, to be a view of the under side of a series of steps; the view representing the structure of overhanging solid masonwork seen from underneath. At first it may be difficult

to see it thus, because the view of steps which we are about to mount is a more natural and frequent experience than the other; but by staring at it with the intention of seeing it differently the transition will come, and often quite unexpectedly.

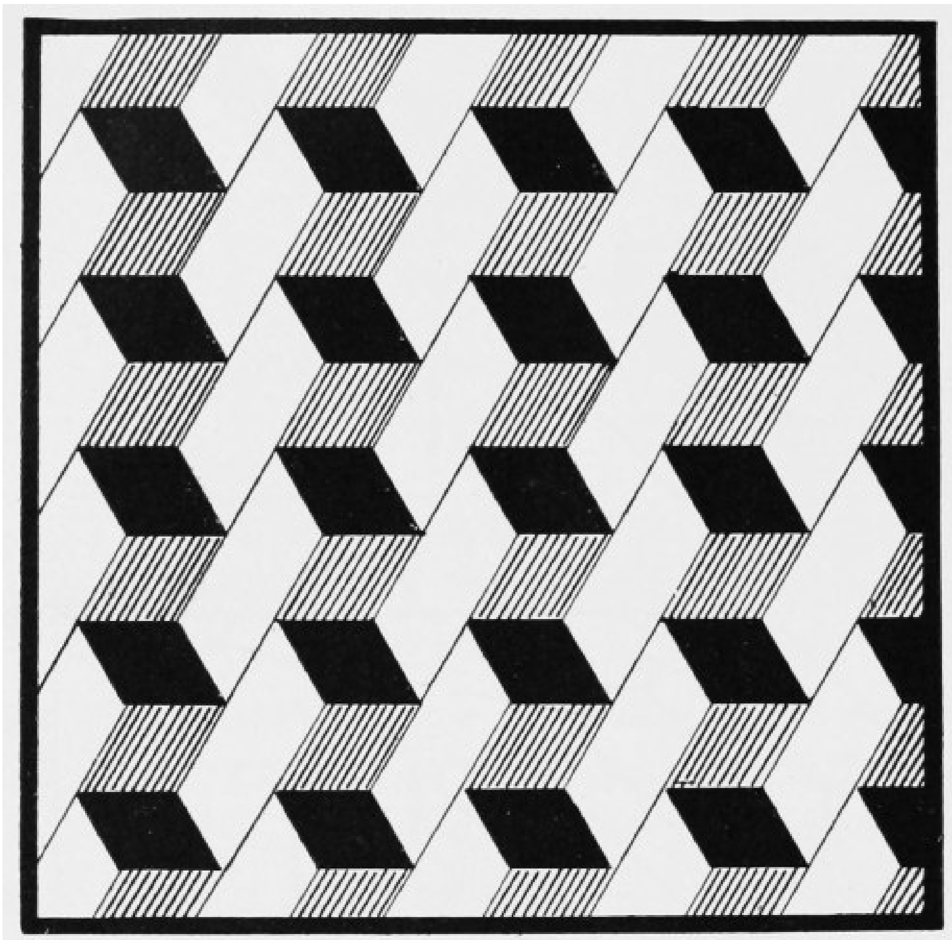
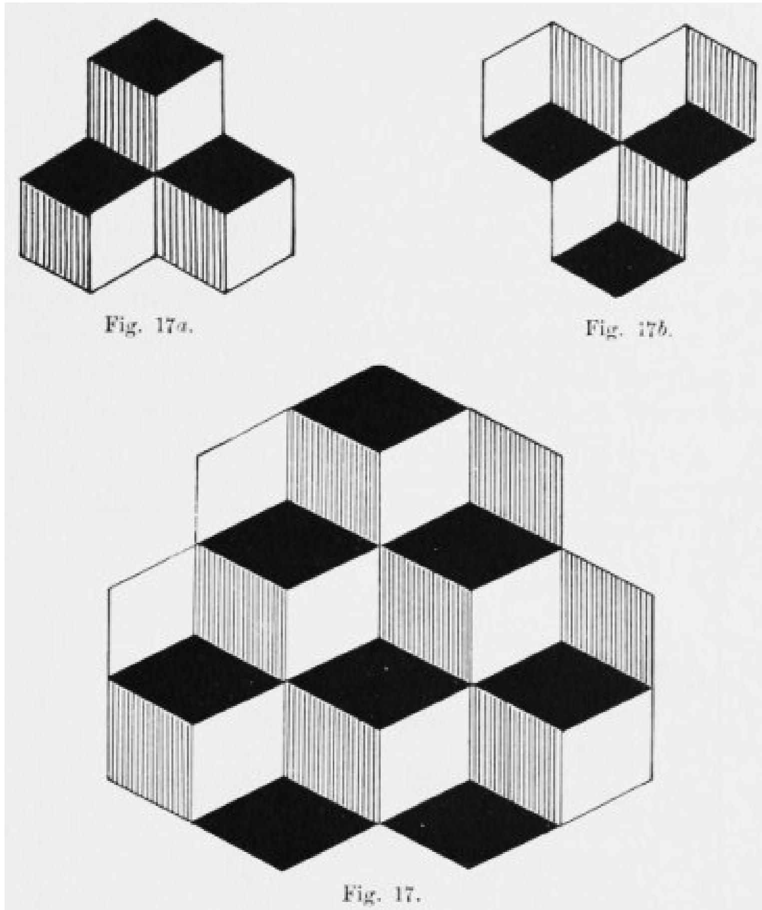


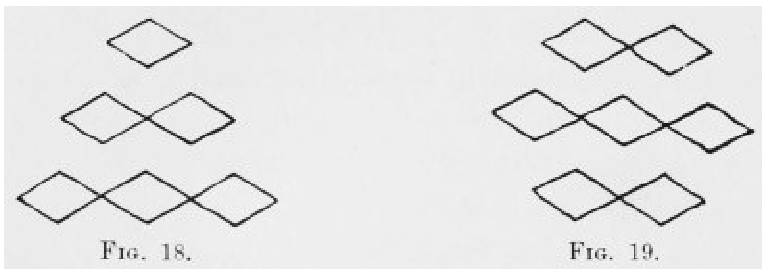
Fig. 16.—This interesting figure (which is reproduced with modifications from Scripture—The New Psychology) is subject in a striking way to interchanges between foreground and background. Most persons find it difficult to maintain for any considerable time either aspect of the blocks (these aspects are described in the text); some can change them at will, others must accept the changes as they happen to come.



Figs. 17, 17*a*, and 17*b*.—How many blocks are there in this pile? Six or seven? Note the change in arrangement of the blocks as they change in number from six to seven. This change is illustrated in the text. Figs. 17*a* and 17*b* show the two phases of a group of any three of the blocks. The arrangement of a pyramid of six blocks seems the more stable and is usually first suggested; but hold the page inverted, and you will probably see the alternate arrangement (with, however, the black surfaces still forming the tops). And once knowing what to look for, you will very likely be able to see either arrangement, whether the diagram be held inverted or not. This method of viewing the figures upside down and in other positions is also suggested to bring out the changes indicated in Figs. 13, 13*a*, 13*b*, and in Figs. 15, 15*a*, 15*b*.

The blocks in Fig. 16 are subject to a marked fluctuation. Now the black surfaces represent the bottoms of the blocks, all pointing downward and to the left, and now the black surfaces have changed and have become the tops pointing upward and to the right. For some the changes come at will; for others they seem to come unexpectedly, but all are aided by anticipating mentally the nature of the

transformation. The effect here is quite striking, the blocks seeming almost animated and moving through space. In Fig. 17 a similar arrangement serves to create an illusion as to the real number of blocks present. If viewed in one way—the black surface forming the tops of the blocks—there seem to be six arranged as in Fig. 18; but when the transformation has taken place and the black surfaces have become the overhanging bottoms of the boxes, there are seven, arranged as in Fig. 19. Somewhat different, but still belonging to the group of ambiguous figures, is the ingenious conceit of the duck-rabbit shown in Fig. 20. When it is a rabbit, the face looks to the right and a pair of ears are conspicuous behind; when it is a duck, the face looks to the left and the ears have been changed into the bill. Most observers find it difficult to hold either interpretation steadily, the fluctuations being frequent, and coming as a surprise.



FIGS. 18 and 19.

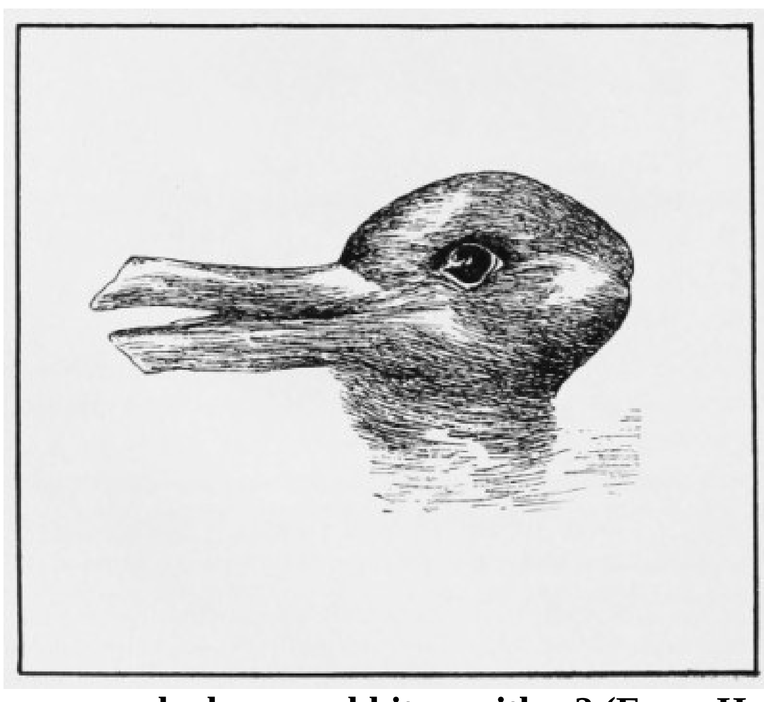


FIG. 20.—Do you see a duck or a rabbit, or either? (From Harper's Weekly, originally in Fliegende Blätter.)

All these diagrams serve to illustrate the principle that when the objective

features are ambiguous we see one thing or another according to the impression that is in the mind's eye; what the objective factors lack in definiteness the subjective ones supply, while familiarity, prepossession, as well as other circumstances influence the result. These illustrations show conclusively that seeing is not wholly an objective matter depending upon what there is to be seen, but is very considerably a subjective matter depending upon the eye that sees. To the same observer a given arrangement of lines now appears as the representation of one object and now of another; and from the same objective experience, especially in instances that demand a somewhat complicated exercise of the senses, different observers derive very different impressions.

Not only when the sense-impressions are ambiguous or defective, but when they are vague—when the light is dim or the forms obscure—does the mind's eye eke out the imperfections of physical vision. The vague conformations of drapery and make-up that are identified and recognized in spiritualistic *séances* illustrate extreme instances of this process. The whitewashed tree or post that momentarily startles us in a dark country lane takes on the guise that expectancy gives it. The mental predisposition here becomes the dominant factor, and the timid see as ghosts what their more sturdy companions recognize as whitewashed posts. Such experiences we ascribe to the action of suggestion and the imagination—the cloud "that's almost in shape like a camel," or "like a weasel," or "like a whale." But throughout our visual experiences there runs this double strain, now mainly outward and now mainly inward, from the simplest excitements of the retina up to the realms where fancy soars freed from the confines of sense, and the objective finds its occupation gone.

NATURE STUDY IN THE PHILADELPHIA NORMAL SCHOOL.

By L. L. W. WILSON, Ph. D.

When it was first proposed to me to write for the Popular Science Monthly a brief account of the biological laboratories in the Philadelphia Normal School, and of the Nature work carried on under my direction in the School of Observation and Practice, I felt that I could not do justice either to the place or the work; for, in my judgment, the equipment of the laboratories and the work done in connection with them are finer than anything else of the kind either in this country or abroad—a statement which it seemed to me that I could not make with becoming modesty. But, after all, it is not great Babylon that I have built, but a Babylon builded for me, and to fail to express my sense of its worth is to fail to do justice to Dr. W. P. Wilson, formerly of the University of Pennsylvania, to whom their inception was due; to Mr. Simon Gratz, president of the Board of Education, who from the beginning appreciated their value, and without whose aid they never would have taken visible form; to the principals of the two schools, and, above all, to my five assistants, whose knowledge, zeal, and hard work have contributed more than anything else to the rapid building up of the work.

The Laboratories and their Equipment.—The rooms occupied by the botanical and zoölogical departments of the normal school measure each seventy by twenty feet. A small workroom for the teachers cuts off about ten feet of this length from each room. In the middle of the remaining space stands a demonstration table furnished with hot and cold water. Each laboratory is lighted from the side by ten windows. From them extend the tables for the students. These give plenty of drawer space and closets for dissecting and compound microscopes. Those in the zoölogical room are also provided with sinks. Each student is furnished with the two microscopes, stage and eyepiece micrometers, a drawing camera, a set of dissecting instruments, glassware, note-books, text-books, and general literature.

The walls opposite the windows are in both rooms lined with cases, in which there is a fine synoptic series.

In the botanical laboratory this systematic collection begins with models of bacteria and ends with trees. In other cases, placed in the adjoining corridor, are representatives, either in alcohol or by means of models, of most of the orders of flowering plants, as well as a series illustrating the history of the theory of cross-fertilization, and the various devices by which it is accomplished; another, showing the different methods of distribution of seeds and fruits; another, of parasitic plants; and still another showing the various devices by means of which plants catch animals.

As an example of the graphic and thorough way in which these illustrations are worked out, the pines may be cited. There are fossils; fine specimens of pistillate and staminate flowers in alcohol; cones; a drawing of the pollen; large models of the flowers; models of the seeds, showing the embryo and the various stages of germination; cross and longitudinal sections of the wood; drawings showing its microscopic structure; pictures of adult trees; and samples illustrating their economic importance. For the last, the long-leaved pine of the South is used, and samples are exhibited of the turpentine, crude and refined; tar and the oil of tar; resin; the leaves; the same boiled in potash; the same hatcheled into wool; yarn, bagging and rope made from the wool; and its timber split, sawn, and dressed.

The series illustrating the fertilization of flowers begins with a large drawing, adapted by one of the students from Gibson, showing the gradual evolution of the belief in cross-fertilization from 1682, when Nehemiah Grew first declared that seed would not set unless pollen reached the stigma, down to Darwin, who first demonstrated the advantages of cross-fertilization and showed many of the devices of plants by which this is accomplished. The special devices are then illustrated with models and large drawings. First comes the dimorphic primrose; then follows trimorphic *Lythrum*, to the beautiful model of which is appended a copy of the letter in which Darwin wrote to Gray of his discovery:

> "But I am almost stark, staring mad over Lythrum.... I should rather like seed of Mitchella. But, oh, Lythrum!
>
> "Your utterly mad friend,
> "C. DARWIN."

Models of the cucumber, showing the process of its formation, and the unisexual flowers complete this series. Supplementing this are models and drawings of a large number of flowers, illustrating special devices by which cross-fertilization is secured, such as the larkspur, butter and eggs, orchids, iris, salvia, several

composites, the milkweed, and, most interesting of all, the Dutchman's pipe. This is a flower that entices flies into its curved trumpet and keeps them there until they become covered with the ripe pollen. Then the hairs wither, the tube changes its position, the fly is permitted to leave, carrying the pollen thus acquired to another flower with the same result.

Pictures and small busts of many naturalists adorn both of the rooms. Of these the most notable is an artist proof of Mercier's beautiful etching of Darwin. Every available inch of wall space is thus occupied, or else, in the botanical laboratory, has on it mounted fungi, lichens, seaweeds, leaf cards, pictures of trees, grasses, and other botanical objects.

The windows are beautiful with hanging plants from side brackets meeting the wealth of green on the sill. Here are found in one window ferns, in another the century plant; in others still, specimens of economic plants—cinnamon, olive, banana, camphor. On the tables are magnificent specimens of palms, cycads, dracænas, and aspidistras, and numerous aquaria filled with various water plants. Most of these plants are four years old, and all of them are much handsomer than when they first became the property of the laboratory. How much intelligent and patient care this means only those who have attempted to raise plants in city houses can know.

The zoölogical laboratory is quite as beautiful as the botanical, for it, too, has its plants and pictures. It is perhaps more interesting because of its living elements. Think of a schoolroom in which are represented alive types of animals as various as these: amœba, vorticella, hydra, worms, muscles, snails and slugs of various kinds, crayfish, various insects, including a hive of Italian bees, goldfish, minnows, dace, catfish, sunfish, eels, tadpoles, frogs, newts, salamanders, snakes, alligators, turtles, pigeons, canaries, mice, guinea-pigs, rabbits, squirrels, and a monkey! Imagine these living animals supplemented by models of their related antediluvian forms, or fossils, by carefully labeled dissections, by preparations and pictures illustrating their development and mode of life; imagine in addition to this books, pamphlets, magazines, and teachers further to put you in touch with this wonderful world about us, and you will then have some idea of the environment in which it is the great privilege of our students to live for five hours each week.

In addition to these laboratories there is a lecture room furnished with an electric lantern. Here each week is given a lecture on general topics, such as evolution and its problems, connected with the work of the laboratories.

THE COURSE OF STUDY PURSUED BY THE NORMAL STUDENTS.—Botany: In general, the plants and the phenomena of the changing seasons are studied as they occur in Nature. In the fall there are lessons on the composites and other autumn flowers, on fruits, on the ferns, mosses, fungi, and other cryptogams. In the winter months the students grow various seeds at home, carefully drawing and studying every stage in their development. Meanwhile, in the laboratory, they examine microscopically and macroscopically the seeds themselves and the various food supplies stored within. By experimentation they get general ideas of plant physiology, beginning with the absorption of water by seeds, the change of the food supply to soluble sugar, the method of growth, the functions, the histology, and the modifications of stem, root, and leaves. In the spring they study the buds and trees, particularly the conifers, and the different orders of flowering plants.

The particular merit of the work is that it is so planned that each laboratory lesson compels the students to reason. Having once thus obtained their information, they are required to drill themselves out of school hours until the facts become an integral part of their knowledge.

For the study of fruits, for example, they are given large trays, each divided into sixteen compartments, plainly labeled with the name of the seed or fruit within. Then, by means of questions, the students are made to read for themselves the story which each fruit has to tell, to compare it with the others, and to deduce from this comparison certain general laws.

After sufficient laboratory practice of this kind they are required to read parts of Lubbock's Flower, Fruit, and Leaves, Kerner's Natural History of Plants, Wallace's Tropical Nature, and Darwinism, etc.

Finally, they are each given a type-written summary of the work, and after a week's notice are required to pass a written examination.

Zoölogy: The course begins in the fall with a rather thorough study of the insects, partly because they are then so abundant, and partly because a knowledge of them is particularly useful to the grade teacher in the elementary schools.

The locust is studied in detail. Tumblers and aquaria are utilized as vivaria, so that there is abundant opportunity for the individual study of living specimens. Freshly killed material is used for dissection, so that students have no difficulty in making out the internal anatomy, which is further elucidated with large, home-

made charts, each of which shows a single system, and serves for a text to teach them the functions of the various organs as worked out by modern physiologists.

They then study, always with abundant material, the other insects belonging to the same group. They are given two such insects, a bug, and two beetles, and required to classify them, giving reasons for so doing. While this work is going on they have visited the beehive in small groups, sometimes seeing the queen and the drone, and always having the opportunity to see the workers pursuing their various occupations, and the eggs, larvæ, and pupæ in their different states of development. Beautiful models of the bees and of the comb, together with dry and alcoholic material, illustrate further this metamorphosis, by contrast making clearer the exactly opposite metamorphosis of the locust.

At least one member of each of the other orders of insects is compared with these two type forms, and, although only important points are considered at all, yet from one to two hours of laboratory work are devoted to each specimen. This leisurely method of work is pursued to give the students the opportunity, at least, to think for themselves. When the subject is finished they are then given a searching test. This is never directly on their required reading, but planned to show to them and to their teachers whether they have really assimilated what they have seen and studied.

After this the myriapods, the earthworm, and peripatus are studied, because of their resemblance to the probable ancestors of insects. In the meantime they have had a dozen or more fully illustrated lectures on evolution, so that at the close of this series of lessons they are expected to have gained a knowledge of the methods of studying insects, whether living or otherwise, a working hypothesis for the interpretation of facts so obtained, and a knowledge of one order, which will serve admirably as a basis for comparison in much of their future work.

They then take up, more briefly, the relatives of the insects, the spiders and crustaceans, following these with the higher invertebrates, reaching the fish in April. This, for obvious reasons, is their last dissection. But with living material, and the beautiful preparations and stuffed specimens with which the laboratory is filled, they get a very general idea of the reptiles, birds, and mammals. This work is of necessity largely done by the students out of school hours. For example, on a stand on one of the tables are placed the various birds in season, with accompanying nests containing the proper quota of eggs. Books and pamphlets relating to the subject are placed near. Each student is given a syllabus which will enable her to study these birds intelligently indoors and out, if she

wishes to do so.

In the spring are taken up the orders of animals below the insect, and for the last lesson a general survey of all the types studied gives them the relationships of each to the other.

THE COURSE OF STUDY PURSUED IN THE SCHOOL OF PRACTICE.—In addition to the plants and animals about them, the children study the weather, keeping a daily record of their observations, and summarizing their results at the end of the month. In connection with the weather and plants they study somewhat carefully the soil and, in this connection, the common rocks and minerals of Philadelphia —gneiss, mica schist, granite, sandstone, limestones, quartz, mica, and feldspar.

As in the laboratories, so here the effort is made to teach the children to reason, to read the story told by the individual plant, or animal, or stone, or wind, or cloud. A special effort is made to teach them to interpret everyday Nature as it lies around them. For this reason frequent short excursions into the city streets are made. Those who smile and think that there is not much of Nature to be found in a city street are those who have never looked for it. Enough material for study has been gathered in these excursions to make them a feature of this work, even more than the longer ones which they take twice a year into the country.

Last year I made not less than eighty such short excursions, each time with classes of about thirty-five. They were children of from seven to fourteen years of age. Without their hats, taking with them note-books, pencils, and knives, they passed with me to the street. The passers-by stopped to gaze at us, some with expressions of amusement, others of astonishment; approval sometimes, quite frequently the reverse. But I never once saw on the part of the children a consciousness of the mild sensation that they were creating. They went for a definite purpose, which was always accomplished.

The children of the first and second years study nearly the same objects. Those of the third and fourth years review this general work, studying more thoroughly some one type. When they enter the fifth year, they have considerable causal knowledge of the familiar plants and animals, of the stones, and of the weather. But, what is more precious to them, they are sufficiently trained to be able to look at new objects with a truly "seeing eye."

The course of study now requires general ideas of physiology, and, in consequences, the greater portion of their time for science is devoted to this subject. I am glad to be able to say, however, that it is not "School Physiology"

which they study, but the guinea-pig and The Wandering Jew!

In other words, I let them find out for themselves how and what the guinea-pig eats; how and what he expires and inspires; how and why he moves. Along with this they study also plant respiration, transpiration, assimilation, and reproduction, comparing these processes with those of animals, including themselves.

The children's interest is aroused and their observation stimulated by the constant presence in the room with them of a mother guinea-pig and her child. Nevertheless, I have not hesitated to call in outside materials to help them to understand the work. A series of lessons on the lime carbonates, therefore, preceded the lessons on respiration; an elephant's tooth, which I happened to have, helped to explain the guinea-pig's molars; and a microscope and a frog's leg made real to them the circulation of the blood.

In spite of the time required for the physiology, the fifth-year children have about thirty lessons on minerals; the sixth-year, the same number on plants; and the seventh-year, on animals; and it would be difficult to decide which of these subjects rouses their greatest enthusiasm.

PRINCIPLES OF TAXATION.[6]

By the Late Hon. DAVID A. WELLS.

XX.—THE LAW OF THE DIFFUSION OF TAXES.

PART I.

No attempt ought to be made to construct or formulate an economically correct, equitable, and efficient system of taxation which does not give full consideration to the method or extent to which taxes diffuse themselves after their first incidence. On this subject there is a great difference of opinion, which has occasioned, for more than a century, a vast and never-ending discussion on the part of economic writers. All of this, however, has resulted in no generally accepted practical conclusions; has been truthfully characterized by a leading French economist (M. Parieu) as marked in no small part by the "simplicity of ignorance," and from a somewhat complete review (recently published[7]) of the conflicting theories advanced by participants one rises with a feeling of weariness and disgust.

The majority of economists, legislators, and the public generally incline to the opinion that taxes mainly rest where they are laid, and are not shifted or diffused to an extent that requires any recognition in the enactment of statutes for their assessment. Thus, a tax commission of Massachusetts, as the result of their investigations, arrived at the conclusion that "the tendency of taxes is that they must be paid by the actual persons on whom they are levied." But a little thought must, however, make clear that unless the advancement of taxes and their final and actual payment are one and the same thing, the Massachusetts statement is simply an evasion of the main question at issue, and that its authors had no intelligent conception of it. A better proposition, and one that may even be regarded as an economic axiom, is that, regarding taxation as a synonym for a force, as it really is, it follows the natural and invariable law of all forces, and distributes itself in the line of least resistance. It is also valuable as indicating the line of inquiry most likely to lead to exact and practical conclusions. But beyond this it lacks value, inasmuch as it fails to embody any suggestions as to the best

method of making the involved principle a basis for any general system for correct taxation; inasmuch as "the line of least resistance" is not a positive factor, and may be and often is so arranged as to make levies on the part of the State under the name of taxation subservient to private rather than public interests. Under such circumstances the question naturally arises, What is the best method for determining, at least, the approximative truth in respect to this vexed subject? A manifestly correct answer would be: *first*, to avoid at the outset all theoretic assumptions as a basis for reasoning; *second*, to obtain and marshal all the facts and conditions incident to the inquiry or deducible from experience; *third*, recognize the interdependence of all such facts and conclusions; *fourth*, be practical in the highest degree in accepting things as they are, and dealing with them as they are found; and on such a basis attention is next asked to the following line of investigations.

It is essential at the outset to correct reasoning that the distinction between *taxation* and *spoliation* be kept clearly in view. That only is entitled to be called a tax law which levies uniformly upon all the subjects of taxation; which does not of itself exempt any part of the property of *the same* class which is selected to bear the primary burden of taxation, or by its imperfections to any extent permits such exemptions. All levies or assessments made by the State on the persons, property, or business of its citizens that do not conform to such conditions are spoliations, concerning which nothing but irregularity can be predicated; nothing positive concerning their diffusion can be asserted; and the most complete collection of experiences in respect to them can not be properly dignified as "a science." And it may be properly claimed that from a nonrecognition or lack of appreciation of the broad distinction between taxation and spoliation, the disagreement among economists respecting the diffusion of taxes has mainly originated.

With this premise, let us next consider what facts and experiences are pertinent to this subject, and available to assist in reaching sound conclusions; proceeding very carefully and cautiously in so doing, inasmuch as territory is to be entered upon that has not been generally or thoroughly explored.

The facts and experiences of first importance in such inquiry are that the examination of the tax rolls in any State, city, or municipality of the United States will show that surprisingly small numbers of persons primarily pay or advance any kind of taxes. It is not probable that more than one tenth of the adult population or about one twentieth of the entire population of the United States ever come in contact officially with a tax assessor or tax collector. It is also

estimated that less than two per cent of the total population of the United States advance the entire customs and internal revenue of the Federal Government.

In the investigations made in 1871, by a commission created by the Legislature of the State of New York to revise its laws relative to the assessment and collection of taxes, it was found that in the city of New York, out of a population of over one million in the above year, only 8,920 names, or less than one per cent of this great multitude of people, had "any household furniture, money, goods, chattels, debts due from solvent debtors, whether on account of contract, note, bond, or mortgage, or any public stocks, or stocks in moneyed corporations, or in general any personal property of which the assessors could take cognizance for taxation"; and further, that not over *four* per cent, or, say, forty thousand persons out of the million, were subject to any primary tax in respect to the ownership of any property whatever, real or personal; while only a few years subsequent, or in 1875, the regular tax commissioners of New York estimated that of the property defined and described by the laws of the State as personal property, an amount approximating two thousand million dollars in value was held in New York city alone. Later investigations show that this state of things has continued. Thus, in 1895, out of a population of about two million, it was estimated that only seventy-nine thousand, or not over four per cent of the inhabitants of the city, were subject to primary taxation, and that one half the whole amount collected in that year was paid by less than a thousand persons. In the city of Boston, where the tax laws are executed in the most arbitrary manner, the ratio of population directly assessed is somewhat greater, but aside from the poll tax, which is a per capita and not a property tax, only 7.27 per cent of residents paid a property tax in 1895 out of a population of 494,205. In one of the smaller cities of Massachusetts, where persons and property are capable of more thorough supervision than larger numbers and areas—namely, the city of Springfield, with a population of about fifty thousand—the report of its tax officials shows that for the year 1894-'95 the number of persons and corporations assessed on property (mainly real estate) was 7,745, or one for every 6.4 of its citizens, while 10,560 other citizens were assessed for a poll tax of two dollars only. Of the total amount of taxes assessed—namely, $735,948—the above number, 10,560, paid only $21,120; and this is the experience generally throughout the United States, as it will be in every country under a free popular government, where arbitrary inquisitions and arrests of persons and seizures of property are not allowed, and where a soldier does not practically stand behind every tax assessor and collector.

The time (1871) when the personal investigations above referred to were made was when the masses of the city of New York were moved with indignation at the misuse and private appropriation by a few officials (Tweed and his associates) of the municipal revenues raised by taxation, under cover of instituting public improvements, and which finally led to their prosecution, imprisonment, or self-imposed exile; and the questions which naturally suggested themselves were: If only some forty thousand of the million in New York city paid the taxes, what interest had the other nine hundred and sixty thousand who never saw the face of a tax assessor or collector in opposing corruption? What, in an honest administration of the city government and in a reduction of taxes? Must it not be for the interest of the many that the expenditures of the State shall always be as large as possible? Must they not be benefited by exorbitant taxes on the owners of property, and a distribution of the money collected, even if stolen by corruptionists, but spent by them lavishly on enterprises that will furnish new opportunities for employment or amusement for the masses? Clearly, so far as any personal experience growing out of any *direct* assessment and levy was concerned, ninety-six per cent of the population of the city had no more cause of personal grievance by reason of the unlawful taking of money from the city treasury than they would have had at the taking of an equivalent amount from the municipal treasuries of London, Paris, or any other city.

The answer to these questions is to be found in the fact, as John Adams once remarked, that "if the Creator had given man a reason that is fallible, he has also impressed upon him an instinct that is sure." And this instinct teaches the masses everywhere, though they have never read a book on political economy, or heard any one discourse learnedly on the principles of taxation, that if taxes are increased, either by a lawful or unlawful expenditure of public money, they can not in any possible way avoid paying some portion of its increase; or, in other words, that increased taxes meant increased cost of living, through increased rents, increased price of fuel, clothing, and provisions, and possibly diminished opportunity to labor through such increased cost of the products of labor as would limit and restrict markets or consumption. In short, that taxes inevitably fall upon them through the increased price of all they consume, even if they pay nothing to the tax collector directly. A large proportion of the masses of the city of New York in 1871-'72, who paid no taxes directly, accordingly and spontaneously joined hands with the comparatively few of their fellow-citizens who did pay in resisting extravagance and corruption.[8]

We are thus led up and forced to the recognition of two propositions, or rather principles, in respect to taxation that can not be invalidated. The *first* is, that it is not necessary that a tax assessor or collector should personally assess and levy upon every citizen of a State or community in order that all should be compelled to contribute of his property for the support of such State or community; *second*, that there is an inexorable law by which every man must bear a portion of the burden of public expenditures, even though the official assessors take no direct cognizance of him whatever.

The following incident may here be cited as instructive: In one of the recent official hearings before a legislative committee of one of the States, a strenuous advocate of the popular doctrine that there was and could be no such thing as equality in taxation except by rigidly taxing everybody directly for all his property, of every description, both real and personal, and that to not tax immediately and directly was, in at least a great degree, to exempt from taxation, expressed himself as entirely opposed to any system of restricting assessments to a comparatively few things, on the ground that it would be a recognition in the United States of a system which in Great Britain had ground down the masses into poverty. He, however, obtained some new light on the subject of nondiffusion by being reminded that if the masses of England had been grievously oppressed by taxation, it had been under a system of many years' standing, which never in any way brings the tax collector in direct contact with nineteen twentieths of the entire population; the customs taxes of Great Britain being practically levied on only four articles—spirits, tea, coffee, and tobacco; and the inland revenue also on practically four—spirits, beer, legacies and successions, and stamps (on deeds, insurance policies, bills of exchange, receipts, drafts, etc.). Generalizing, then, on the basis of so broad a fact, how illogical and unscientific was the assumption that whatever persons, property, or business are not taxed directly are exempt from taxation!—and yet the practical exemplification of such a system, in the case of England, was a most efficient instrumentality for grinding the masses of her people down to poverty.

On the other hand, to generalize from the experience of an individual or a class in place of that of a nation or community, let us take the case of a person who passes all the year *in transitu*—moving backward and forward, for example, in a boat on the line of the Erie Canal, or between the head waters of the Mississippi and its mouth; a citizen of no one State, a resident in no one town, and buying all that he eats, drinks, and wears wherever he can buy cheapest. Does this man escape taxation because he has no permanent *situs* (residence as a citizen), and is

unknown by any assessor? If he does, then his occupation is more profitable to the extent of the taxes he avoids than is that of the individual who, following analogous occupations, resides permanently in one location, and pays taxes regularly; or else some notable, easily discernible cause, as undue competition to obtain situations, will account for his exemption.

Let us next consider how practical experience definitely indicates the line of least resistance, in conformity with which those contributions of property or service which the State requires its citizens to make for its support, and are worthy of designation as taxes, diffuse themselves. Let us take first that form of indirect taxation which is known as customs, or taxes on imports, one from which the Federal Government of the United States has derived in recent years more than half of its revenue, and Great Britain more than one fourth of its total receipts from all forms of imperial taxes. That all such taxes as a rule diffuse themselves, and ultimately fall upon and are paid by final consumers, is capable of demonstration by a great variety of evidence. Every remission of customs duties on the imports into any country of its staple articles of consumption is followed by a reduction of cost approximately equal to such reduction, and a consequent increase in consumption. On the other hand, nothing is better settled than that an increase in customs taxes on imported articles as a rule increases prices and tends to reduce consumption. When Great Britain, in 1863, reduced her taxes (duties) on her imports of tea from 1*s.* 5*d.* to 1*s.* per pound, her importation of tea increased from 114,000,000 pounds in 1862 to 139,000,000 in 1866, and her per capita consumption during the same period from 2.70 pounds to 3.42 pounds; and again, when the duty was further reduced in 1865 from 1*s.* to 6*d.* per pound, the annual importations increased from 139,000,000 in 1866 to 209,000,000 in 1881, and the per capita consumption from 3.42 pounds to 4.58.

When by the act of October, 1890, the tax was removed from the imports of crude sugars into the United States, the price of the same went down almost immediately to an equal extent in all American markets; while the consumption of sugar in the country increased from an average of about fifty-four pounds per capita in 1890 to more than sixty-seven pounds in 1892. A like result has attended a similar experience in respect to this in other countries, and especially in Great Britain. Thus, the aggregate consumption of sugar by the British people in 1844 was returned at 237,143 tons. A reduction of taxes on its importation in 1864 increased its domestic use to 528,919 tons; a reduction of fifty per cent on existing rates in 1870 made it 695,029 tons; another reduction of fifty per cent in 1873 carried up consumption to 779,000 tons; and when, in 1874, all taxes on

the imports of sugar were abolished, the annual domestic consumption increased in little more than a year's period to 930,000 tons. On the other hand, when by the tariff act of 1890 an additional tax of half a cent per pound was imposed on the import of tin plate into the United States, tin plate went up to an equal extent in price all over the country; and so also on pearl buttons, linen goods, and other articles of foreign production on the importations of which the tariff taxes were largely increased. By the tariff act of 1890, also, eggs, which could formerly be imported into the United States free of duty, were made subject to a tax of five cents per dozen. Since then the price of eggs imported from Canada into districts of the United States within the same sphere of territorial competition has been increased to the American consumers to almost exactly the extent of the import tax to which they are subjected. Thus, when the price of eggs was ten and a half cents per dozen in Toronto, they were sixteen cents in Buffalo and sixteen and a half to seventeen cents in New York. Such a result would be unaccountable if the Canadian farmers paid the duty on eggs sent by them to the United States.

It is interesting to here ask attention to the opinions entertained and expressed by those whose situation and experience have qualified them to speak with authority: "The duty constitutes the price of the whole mass of the article in the market. It is substantially paid on the article of domestic manufacture, as well as that of foreign production" (John Quincy Adams). "I said it, and I stand by it, that as a general rule the duties paid on imports operate as a tax upon the consumer" (John Sherman). Mr. Blaine, in his Twenty Years in Congress, says, speaking of the increase of duties on imports by the tariff act of July 14, 1862, that it "shut out still more conclusively all competition from foreign fabrics. The increased cost was charged to the consumer." Mr. McKinley, in 1890, in a report introducing a bill for revision of the tariff of the United States, in the direction of increased rates of duties on imports, said it was not the intent of the bill "to further cut down prices," that the people were "already suffering from low prices," and would not be satisfied "with legislation which will result in lower prices." In an elaborate opinion given by the New York Court of Appeals in 1851 (see vol. iv, New York Reports), in which there was no suspicion of any issue of free trade or protection, the courts, in carefully considering the relative powers of the legislature and the judiciary in respect to taxation, assumed the proposition that "*all duties on imported goods are taxes on the class of consumers*" to be in the nature of a self-evident truth or economic axiom.

Henry Clay, in a celebrated speech in the United States House of Representatives in 1833, in advocacy of a protective tariff policy, candidly admitted that "in

general it may be taken as a rule that the duty upon an article forms a portion of its price." But he subsequently qualified such admission by claiming that it does not follow that any consequent enhancement of its price is a tax on consumers, inasmuch as "directly or indirectly, in one form or another, all consumers of protected articles, enhanced in price," will get an equivalent. But this may be equally affirmed of all necessary and equitable taxation, and does not in any way antagonize the theory that the final incidence of the class of taxes under consideration falls on consumption.

But, notwithstanding these conclusions and the incontrovertible evidence by which they are supported, not a few persons occupying places of great legislative influence, and no small part of the general public, hold to the view that taxes on imports are really in the nature of premiums paid by foreigners for the privilege of selling their goods in the markets of the importing country, and do not fall on its people who consume them. That means that if the foreigner has a yard of cloth, or other commodity, which he sells at home for one dollar, and the United States imposes a tariff of fifty cents on it, he will then sell it for export to America at fifty cents. There is no instance mentioned in history where this has ever been done, but history unfortunately is rarely taken into account by the public in the discussion of these questions. In this connection the following historical incident is interesting and instructive: In 1782 an attempt by the Congress of the Confederation of the several American States to provide a system of revenue to defray the general expenses of the Confederation by duties on imports, which then was not permissible, was blocked by the refusal of the State of Rhode Island to concur in it, the Legislature of that State unanimously rejecting the measure for three reasons—one of which was that it would bear hardest on the few commercial States, particularly Rhode Island, which in virtue of their relations with foreign commerce monopolize imports, and lightest on the agricultural States, that directly imported little or nothing. Congress appointed Alexander Hamilton to draft a reply to Rhode Island, and in his answer he relied mainly on what he regarded as an incontrovertible fact, that duties on imports would not prove a charge on an importing State, but on the final consumers of imports, wherever they may be located.

If the theory and assumption so confidently and generally asserted are to be accepted as correct, that the foreigner pays the protective taxes which a country levies on its imports, and that they do not fall upon or are not paid by its people who consume them, then it must follow that to the extent that a country taxes its imports it lives at the expense of foreign nations; and that, as Great Britain is the

country with which the United States has the largest foreign trade, it must pay the largest share of the customs taxes of the United States, or a good share of its annual revenue from all sources. Attention is further asked to the exact practical application of this theory. Thus, the United States in 1895 imported $36,438,196 worth of woolen manufactures, on which it assessed and collected duties (taxes) to the amount of $20,698,264, or 56.80 per cent of the value of such imports. Certainly this was a pretty heavy tax on foreign nations in respect to the sales of only one class of these commodities; but it represented but a tithe of what the tariff taxes of the United States, if paid by foreigners, cost them. Thus they had to sell their woolens to the people of the latter country at less than half their value in order to compensate for the 56.8 per cent tax. But a nation engaged in foreign trade can not as a rule have two prices for the product of its industries; or one price for what it sells at home and another and different price for what it sells to foreigners. So the fifty-six per cent deducted from the cost of the woolens sold by foreigners to the United States necessarily had to be deducted not only from so much of their product consumed at home, but also from what they sent for sale to all foreign countries. A further practical application of this theory is worthy of consideration. As Great Britain imposes no protective duties or taxes on its imports, it evidently can not collect anything from other nations by the system of taxation under consideration. On the other hand, the aggregate value of its exports sent to foreign nations during the year 1892 was $1,135,000,000, and if these several nations taxed this value at the average rate which the United States imposed in 1894 on all its dutiable imports—namely, fifty per cent—Great Britain obviously had to pay some $557,000,000 in that year for the support of foreign governments; and while this has been the experience of Great Britain for more than forty years of this century, she has as a nation been increasing in wealth during this whole period.

Some of the recent official experiences of the Government of the United States that are pertinent to the topic under consideration are sufficiently curious to make them worthy of an economic record. In a speech introducing a bill into the United States House of Representatives, which subsequently resulted in the tariff act of 1890, the then chairman of the Committee of Ways and Means laid down the following proposition: "The Government ought not to buy abroad what it can buy at home. Nor should it be exempted from the laws it imposes upon its citizens."

This would seem to warrant the characterization of a discovery that the United States had some reliable and important source of revenue independent of

taxation,[9] and that, by compelling the application of a part of this income to the payment of taxes to itself, the Government is placed upon an equality with the citizens. A legitimate criticism on this proposition is that the idea that all the income of the Treasury is derived from the people, and that to transfer portions of this income from one official recipient to another can have hardly any other result than an additional cost of bookkeeping, seems never to have entered the mind of the speaker.

Again, the United States tariff act of 1883 contained in its free list a provision for the admittance of "articles imported for the use of the United States, provided that the price of the same did not include the duty" imposed on such importations. Under the tariff act of 1890 this provision was stricken out of the statute, with the result that when the Government imported any articles for its own use which were subject to duties (as, for example, materials to be used in the National Bureau of Printing and Engraving), it was obliged, in virtue of its nonexemption from the laws which it imposed on its own citizens, to pay such duties itself. But as the Government has no authority to expend money for any purpose without the authority of Congress, the latter body accordingly authorized the Federal Treasury to appropriate money from its tax receipts and make payments with the same to the customhouse, which the customhouse was to immediately pay back into the Treasury. Just what process was gone through with to effect such a result the public was not informed, but probably the collector of customs drew his warrant on the Treasury, had the amount credited to his account, and then recredited to the Treasury. But, be this as it may, it is clear that the Government, under the conditions above stated, paid the tax on its imports; that the tax may be regarded in the light of a penalty on the Government for importing articles for its own use; and that the action of Congress in authorizing the Treasury to appropriate money for the payment of such taxes was a recognition or admission by that body that a tax upon imports neither puts anything *in* nor takes anything *from* the pocket of the foreigner. Does it not, moreover, invest with a degree of comicality a law enacted by the Congress of the United States for the purpose of taxing foreign importers, which necessitated the enactment by it of another law appropriating money to enable the United States to pay customs taxes every time on everything that it may import for its own use?[10] Finally, if the foreigner and not our citizens pays our customs taxes on imports, what is the object of placing by specific statutes any article on the free list? Why not let him continue to pay millions of taxes for us, as, for example, on sugar?

OUR FLORIDA ALLIGATOR.

By I. W. BLAKE.

An alligator is not an attractive creature. He has not a single virtue that can be named. He is cowardly, treacherous, hideous. He is neither graceful nor even respectable in appearance. He is not even amusing or grotesque in his ungainliness, for as a brute—a brute unqualified—he is always so intensely real, that one shrinks from him with loathing; and a laugh at his expense while in his presence would seem curiously out of place.

His personality, too, is strong. Once catch the steadfast gaze of a free, adult alligator's wicked eyes, with their odd vertical pupils fixed full upon your own, and the significance of the expression "evil eye," and the mysteries of snake-charming, hypnotism, and hoodooism will be readily understood, for his brutish, merciless, unflinching stare is simply blood-chilling.

Zoölogically the alligator belongs to the genus *Crocodilus*, and he has all the hideousness of that family, lacking somewhat its bloodthirstiness, although the American alligator is carnivorous by nature, and occasionally cannibalistic. Strictly speaking, however, the true alligator is much less dangerous than his relatives of the Old World, and he is correspondingly less courageous.

One would suppose the saurians, or crocodilians, from their general appearance to be huge lizards, but the resemblance is superficial. The whole internal structure differs widely, and, subdivided into gavials, crocodiles, and alligators, they form a family by themselves which is widespread, extending into considerable areas of the temperate regions.

All crocodilians are great, ungainly reptiles, having broad, depressed bodies, short legs, and long, powerful, and wonderfully flexible tails which are compressed—that is, flattened sideways. Upon the upper surface of the tail lie two jagged or saw-toothed crests, which unite near the middle of the appendage, continuing in a single row to the extremity.

All have thick necks and bodies protected by regular transverse rows of long, horny plates or shields, which are elevated in the center into keel-shaped ridges, forming an armor that is quite bullet-proof. The throat, the under side of the

neck, and belly are not thus protected, and it is at these places, as well as at the eyes, and also just behind the ears, that the hunter directs his aim.

The principal points of difference between a gavial and a crocodile are these: the former has very long, slender jaws, set with twenty-seven teeth in each side of the upper jaw and with twenty-five teeth in the under, while at the extremity of the snout there are two holes, through which pass upward the lower large front teeth, but all the remaining teeth are free, and slant well outward; whereas a crocodile has a head that is triangular, the snout being the apex; a narrow muzzle, and canine teeth in the lower jaw, which pass freely upward in the notches in the side of the upper jaw.

An alligator has a broad, flat muzzle, and the canine teeth of the lower jaw fit into sockets in the under surface of the upper jaw. It is strictly an American form of the family. Its feet being much less webbed, its habits are also less perfectly aquatic, and, preferring still or stagnant fresh-water courses or swamps, it is rarely found in tide-water streams.

The crocodile, on the contrary, is commonly found in swift-running, fresh and salt water rivers. He is a sagacious brute, and ferocious, often attacking human beings without provocation; but the alligator, as a rule, is not disposed to fight, although in South America, where it goes by the name of *caiman* or *cayman*, it grows to an enormous size, and is said to be fully as dangerous as the crocodile. There is also a variety of the family—that is, a true crocodile—found in Florida, but it is very rare, and smaller than its Asiatic relative.

The mouths of all these reptiles, which are large and extend beyond the ears, present a formidable array of sharp, conical teeth of different sizes, set far apart in the crocodile and the alligator, some being enlarged into tusks. All are implanted in separate sockets, and form a single row upon each jaw. When a tooth is shed or broken, a new one promptly comes up beneath the hollow base of the old one; and in this way, all ready for the need, sometimes three or four waiting teeth, packed together like a nest of thimbles, may be seen in the jaw of a dead alligator.

Young Pet Alligator. From photograph by E. L. Russell, Palm Beach.

The alligator is at best an awkward brute. Slow and ungainly upon land—although even there his powerful tail can, when necessary, assist the scuffling paws to an astonishing extent if the creature is in haste—he shows to better advantage in the water. There he turns his clumsy body with wonderful dexterity and swiftness, when, at the sight of a swimming muskrat or a wading dog, he instantly changes from what has resembled a drifting log idly floating upon the calm surface of the swamp, into a thing of life—fierce and horrible.

The general food of an alligator is fish, turtles, and frogs, with an occasional heedless dog or fowl. A number of adult alligators will quickly deplenish a small, clear-water lake of its finny inhabitants, which statement to would-be Florida fishermen will readily account for the lack in many localities. There is also a curious belief in the South that the creature has an especial liking for a "darkey steak," and for this reason he is feared by the negroes. That he becomes carnivorous to a dangerous extent when pressed by hunger, there is no doubt, for, the supply of fish exhausted, he must look for larger game.

Partially concealed by rubbish, or floating idly close to the bank—always only a

short distance from his retreat—he so closely resembles an old and weather-worn log that no suspicion is aroused. Presently a razorback comes down the narrow trail that meanders through the scrub and passes close to the reptile. Let it pass between the alligator and the water—that is, between the creature and his *cave*—and the end has come. An alligator seldom misses, and one spring, leap, or plunge, or whatever the swift, clumsy movement may be called, and the wretched animal is seized and held fast, either by the nose or leg, as a rule. Then the struggle begins, for the razorback loves its life, despised pig of the Florida flatwoods though it is.

Alligators drown their prey. Their own nostrils and throats are so arranged that they themselves can sink to the bottom without danger of suffocation, although their mouths, or rather their jaws, may be widely stretched with the body of their victim. Indeed, they can reascend to the surface to breathe without releasing the prize; and, as this power is so closely connected with their method of killing the larger animals, a description of the latter, repulsive though it is, may not be out of place.

The teeth of an alligator are better adapted for crushing and crunching than for biting. Therefore, for him to eat a struggling animal would be difficult. Instinct teaches him that it must first be killed.

To dispose of a dog or a chicken is a small matter, for when the alligator meets it upon the bank one strong, far-reaching sweep of the powerful tail tosses it far out upon the lake. The alligator simply follows, grasps the half-stunned creature in his jaws, and disappears beneath the surface, where he remains until all is quiet. With a larger animal, however, he proceeds differently, for the reason that a yearling, a colt, or a razorback is not so easily handled. First, therefore, a description of an alligator's cave must be given, since it is to this grewsome retreat that the hideous brute takes his booty.

Selecting some spot where the water is deep—usually beneath some overhanging bank—an alligator excavates what is called a "cave." Any one, standing upon the border of a lake or swamp in Florida, may, all unconsciously, be directly over one of these places. He makes it sufficiently large to accommodate one or more of his kind, by dragging out the mud and roots with the strong claws or nails that arm his fore paws or legs. These "caves" serve in winter for hibernation, and at other times for the purpose that will be explained.

Once in the water, then—to return to the unhappy razorback—the alligator does

not rely wholly upon his teeth and jaws to hold the desperate animal. He can not yet sink, for the victim is too strong. It must first be drowned, and a furious struggle for the mastery then begins.

By degrees the brute finally succeeds in dragging the animal out into water sufficiently deep to suit his purpose, and then he clasps it firmly with his paws, precisely like the hugging of a bear. He then begins to roll over and over. Now beneath the surface, now out, he turns and turns, first the alligator uppermost, then his prey, alternately, until the poor animal is drowned literally by inches. Before long the razorback weakens, his struggles lessen, and then the alligator sinks to the bottom, and when all motion has ceased he deposits the body in his cave, well pleased with the prospect of a full larder for some time to come.

One might naturally ask just here whether or not this scene would be the same were a human being the victim. The reply would be—precisely.

The alligator undoubtedly prefers his food in a partly decomposed condition, although it is an undecided point whether this preference arises from a natural taste, or for the reason that food in that state is softer and more easily torn apart. Whichever may be the case, Nature unasked supplies the remedy, and the alligator takes advantage of her assistance, and deposits his victim in his hiding place, confident that at the proper time it will rise to the surface in the condition best adapted to his needs.

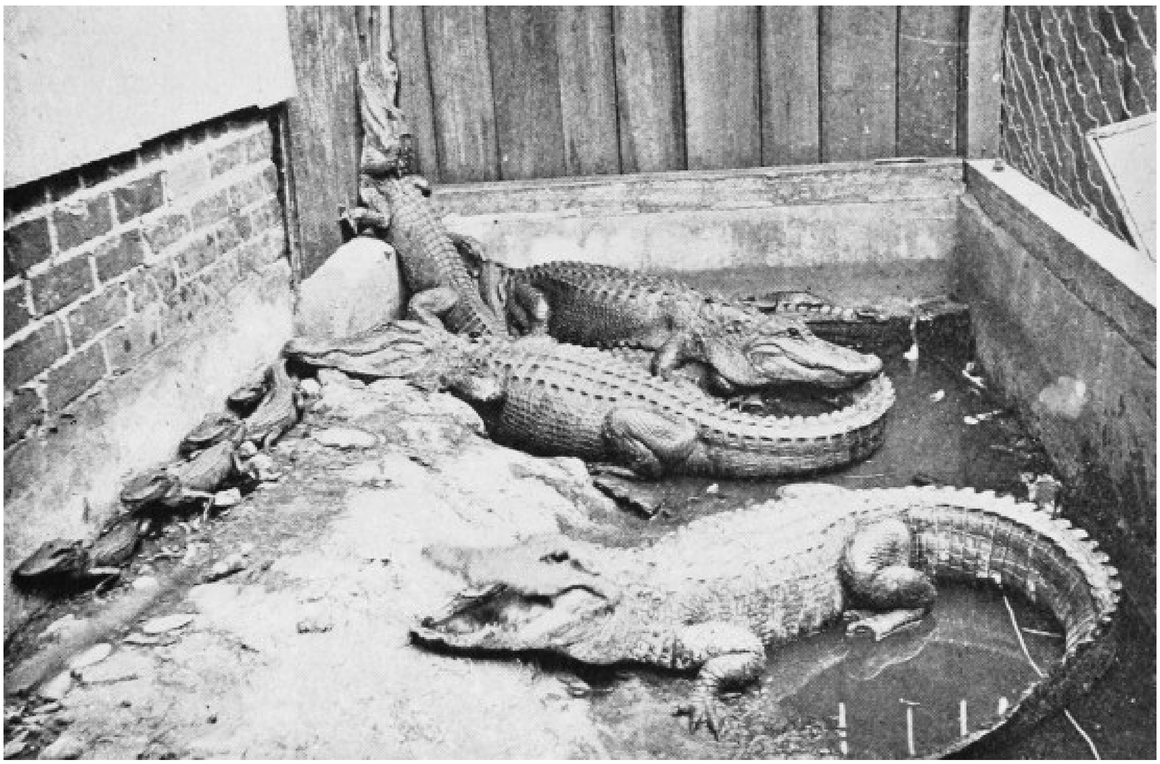
Although by nature the alligator is amphibious, he passes the greater part of his time upon land during the breeding season. At such times, also, he migrates from one clear-water lake or swamp to another, should he not find a mate in his own locality, and he may not infrequently be met in his overland journeyings. Alligators are not strictly gregarious, although large numbers are found in the same body of water; while, on the contrary, there will often be but one or two that will haunt a certain tract for a long period.

During this season the bull alligator is very noisy, and his deep bellowing may be heard for a long distance. To state that this noise causes the ground to vibrate may seem an exaggeration, but the fact may easily be proved by visiting a swamp where the reptiles have congregated. The water in the vicinity will plainly show the jarring of the ground.

This bellow is a thundering, rumbling sound; and when it is combined with the startling hisses, blowings, sighs, and deep-breathed snorts which the creature can produce at will, no one will be likely to dispute that his collection of diabolical

noises is quite complete.

During the period of incubation the female alligator is a devoted mother. She does not desert her nest from the time that the eggs are laid until they are hatched —lying concealed in the scrub close by—and she is naturally, at this time, most dangerous to approach, although her vigilance does not always save a portion of her unhatched progeny from the numerous enemies that have a fondness for alligator omelet.



Group of Captive Alligators. From photograph by O. P. Hareus, Jacksonville.

The nest is a large, well-rounded heap or mound, composed of sand and rubbish, which she drags and pushes together with her claws. Throughout this mound she deposits her eggs, from forty to seventy and over. These eggs resemble those of a goose, only that they are larger; they have a thick, tough shell, and are of about the same size at both ends. In about sixty days, the heat of the sun, combined with the warmth and moisture generated by the fermentation of the rubbish, completes the process of incubation, and the little ones begin to come forth.

Forcing their way through the sand, they hurry down the sloping sides of the mound, straightway seeking the water by instinct. While these baby 'gators are thus kicking and flinging off their shell overcoats as they emerge from their

incubator, perfect little duplicates of their mother—only that they are rather pretty in their clean, glossy, black or dark-brown skins, which have orange-colored stripes that completely ring their miniature tails and bodies—she wanders anxiously about, probably wondering how many of her family will succeed in running the very uncertain gantlet of life.

For, eaten while in the egg stage by birds and animals, and swallowed by open-mouthed, expectant fishes, and by other alligators—often led, if the truth must be told, by the interesting father himself—as soon as they reach the water, the early days of an alligator are full of trouble. That enough escape to prevent extinction, however, goes almost without saying.

Alligators are hunted for their teeth, which find a ready market when made up into pretty ornaments; and of late years extensively for their hides, which make a very handsome leather. For this purpose the older specimens are not valuable, their hides being too gnarled, knotty, and moss-grown to tan well. After ten or fifteen years the hide coarsens. It is always the skin from the under side of the body and head which is used, that from the back being so heavily armored with tough, horny plates and shields as to be practically useless. The flesh for food finds but few admirers. Like the eggs, it is permeated by a strong, musky flavor, too rank to find appreciation from a refined palate; but in some places the steaks from the reptile are eaten by the negroes and pronounced good.

To successfully hunt the alligator requires experience, for quick work is necessary, the brute disappearing at the least suspicion of danger. Hunting by "jack" is the usual method pursued, for the light seems to charm the creature, so that he may be more easily detained until a properly directed bullet speedily puts an end to his existence.

A professional alligator hunter, or a "'gator man," as he is called, leads a life full of adventure, but his business is upon the wane, since the fad for alligator leather is being pushed aside to make way for something later and more novel. Nevertheless, a description of his outfit may not be uninteresting.

A most important adjunct to this outfit is the man who usually accompanies the 'gator man upon his expeditions. He might properly be called the silent partner, for his duty is to instantly and silently obey the different hand signals, meaning "To the right," "To the left," "Stop," "Back," "Hurry," "Forward," "Spurt," "Slow," given by the hunter, while standing erect in the bow of the boat, when out with the "jack." Indeed, upon his alertness depends much of the success or

failure of the night's work.

The other tools used by the 'gator man are a light, strong boat, a pair of light oars and a broad-bladed paddle with a four-foot handle, neatly coiled rope, a jack lamp furnished with a powerful reflector, an axe, a long, keen-bladed hunting knife, two guns (twelve-bore breech-loaders, for a heavy charge at one delivery is absolutely necessary), bags of ammunition, some strong chains, rawhide rope, and a 'gator pole. This last-mentioned "tool" is a stout pole about ten feet long, armed with a heavy hook of quarter-inch iron, bearing a barbed shank of two inches or more, and it is used for hauling the dead alligators from the bottom, for the creatures sink as soon as killed.

The brilliant rays from the "jack" reveal a curious and a grewsome sight when thrown upon a bank or island upon which a group of the creatures have congregated. The shining waters of the swamp, so still and black at that hour of midnight; the hideous tangle of huge gray forms, as a dozen or more alligators, fairly intoxicated by the gleam of the mysterious light, steadfastly watch its incomprehensible presence. Gazing intently, their evil eyes blood-red in the glare from the powerful reflector, some lie motionless, others roar and hiss and snort with thrilling fierceness as the mystery deepens, incessantly arching their bodies, then alternately depressing them to the ground. Still others, crawling from beneath their companions, scuffle angrily to the front, and stand with jaws partly open—now and then slowly inflating their lungs, until their throats and sides puff out like bellows. Yet, strange to say, instinct seems to warn the mother alligator, for there she may be seen quietly creeping away with her young.

Then, the loud reports from the guns, and the mystery is dispelled! The island is deserted, and the work of raising the successfully shot saurians begins.

Boards of rural engineering, syndicates of specialists organized in several of the countries of northern Europe to look after drainage and irrigation, have rendered great services to the populations of the country districts. With their aid 591 villages in Alsace-Lorraine were provided with water between 1881 and 1895, and 516 communes in Baden have been benefited by their assistance. The expense of the improvement has not exceeded $6.61 (33 francs) per inhabitant. The Agricultural Bureau in Prussia has in the past five years drawn the plans and directed the work of 554 hydraulic

syndicates, covering a total surface of more than 600,000 acres. A numerous body of these agricultural engineers is formed every year in Germany, 517 students having pursued the course of the section of rural engineering in 1893 in the agronomical institutes of Bonn and Berlin alone.

It is generally accepted that the spider is a solitary animal, that will tolerate no companions, even the male being in danger of being devoured by his female. But a spider—the *Stregodyphus gregarius*—is described as living in the Transvaal in communities, including males and females, young and old. The nests are sometimes voluminous and have partitions and numerous passages running through them. The spiders usually escape observation by wrapping themselves in dry leaves that hang from stems.

THE RACIAL GEOGRAPHY OF EUROPE.

A SOCIOLOGICAL STUDY.

(*Lowell Institute Lectures, 1896.*)

BY WILLIAM Z. RIPLEY, PH. D.,

ASSISTANT PROFESSOR OF SOCIOLOGY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY;
LECTURER IN ANTHROPO-GEOGRAPHY AT COLUMBIA UNIVERSITY.

SUPPLEMENT.—THE JEWS (*continued*).

Tradition has long divided the Jewish people into two distinct branches: the Sephardim, or southern, and the Ashkenazim, or north, European. Mediæval legend among the Jews themselves traced the descent of the first from the tribe of Judah; the second, from that of Benjamin. The Sephardim are mainly the remnants of the former Spanish and Portuguese Jews. They constitute in their own eyes an aristocracy of the nation. They are found primarily to-day in Africa; in the Balkan states, where they are known as Spagnuoli; less purely in France and Italy. A small colony in London and Amsterdam still holds itself aloof from all communion and intercourse with its brethren. The Ashkenazim branch is numerically far more important, for the German, Russian, and Polish Jews comprise over nine tenths of the people, as we have already seen in our preceding article.

Early observers all describe these two branches of the Jews as very different in appearance. Vogt, in his Lectures on Man, assumes the Polish type to be descended from Hindu sources, while the Spanish alone he held to be truly Semitic. Weisbach[11] gives us the best description of the Sephardim Jew as to-day found at Constantinople. He is slender in habit, he says; almost without exception the head is "exquisitely" elongated and narrow, the face a long oval; the nose hooked and prominent, but thin and finely chiseled; hair and eyes generally dark, sometimes, however, tending to a reddish blond. This rufous tendency in the Oriental Jew is emphasized by many observers. Dr. Beddoe[12] found red hair as frequent in the Orient as in Saxon England, although later results do not fully bear it out.[13] This description of a reddish Oriental type

corresponds certainly to the early representations of the Saviour; it is the type, in features, perhaps, rather than hair, painted by Rembrandt—the Sephardim in Amsterdam being familiar to him, and appealing to the artist in preference to the Ashkenazim type. This latter is said to be characterized by heavier features in every way. The mouth, it is alleged, is more apt to be large, the nose thickish at the end, less often clearly Jewish, perhaps. The lips are full and sensual, offering an especial contrast to the thin lips of the Sephardim. The complexion is swarthy oftentimes, the hair and eyes very constantly dark, without the rufous tendency which appears in the other branch. The face is at the same time fuller, the breadth corresponding to a relatively short and round head.

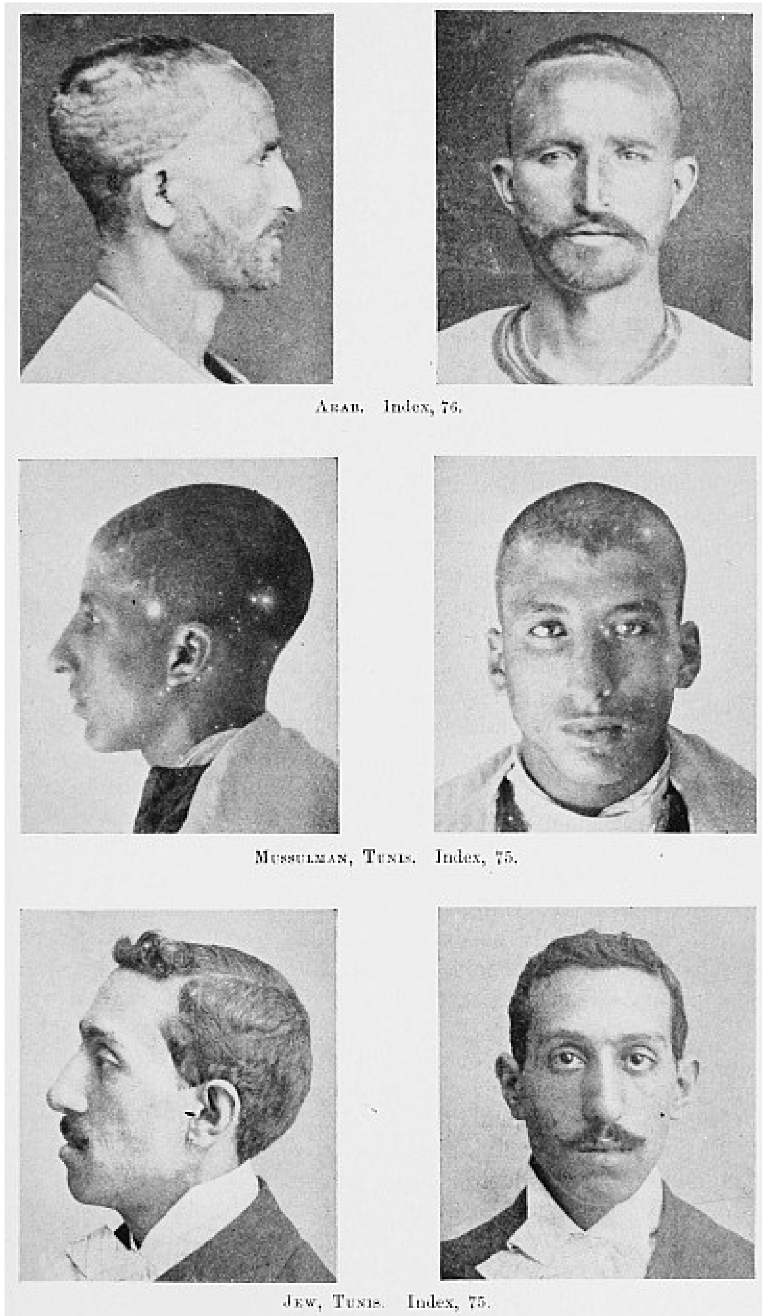
Does this contrast of the traditional Sephardim and Ashkenazim facial types correspond to the anthropometric criteria by means of which we have analyzed the various populations of Europe? And, first of all, is there the difference of head form between the two which our descriptions imply?[14] And, if so, which represents the primitive Semitic type of Palestine? The question is a crucial one. It involves the whole matter of the original physical derivation of the people, and the rival claims to purity of descent of the two branches of the nation. In preceding papers we have learned that western Asia is quite uniformly characterized by an exceeding broad-headedness, the cephalic index—that is to say, the breadth of the head in percentage of the length from front to back—often rising to 86. This is especially marked in Asia Minor, where some of the broadest and shortest crania in the world are to be found. The Armenians, for example, are so peculiar in this respect that their heads appear almost deformed, so flattened are they at the back. A head of the description appears in the case of our Jew from Ferghanah on our second portrait page, 344. On the other hand, the peoples of African or negroid derivation form a radical contrast, their heads being quite long and narrow, with indices ranging from 75 to 78. This is the type of the living Arab to-day. Its peculiarity appears in the prominence of the occipital region in our Arab and other African portraits. Scientific research upon these Arabs has invariably yielded harmonious results. From the Canary Islands,[15] all across northern Africa,[16] to central Arabia itself,[17] the cephalic indices of the nomadic Arabs agree closely. They denote a head form closely allied to that of the long-headed Iberian races, typified in the modern Spaniards, south Italians, and Greeks. It was the head form of the ancient Phœnicians and Egyptians also, as has recently been proved beyond all question.[18] Thus does the European Mediterranean type shade off in head form, as in complexion also, into the primitive anthropological type of the negro. The situation being thus clearly defined, it should be relatively easy to trace our modern Jews, if, indeed,

as has so long been assumed, they have remained a pure and undefiled race during the course of their incessant migrations. We should be able to trace their origin if they possess any distinctive head form, either to the one continent or the other, with comparative certainty.

Authority.	Place.	Number.	Cephalic Index
Lombroso, 1894 a	Turin, Italy.	112	82.0
Weisbach, '77	Balkan states.	19	82.2
Majer and Kopernicki, '77	Galicia.	316	83.6
Blechmann, '82	W. Russia.	100	83.2
Stieda, '83 (Dybowski)	Minsk, Russia.	67	82.2
Ikof, '84	Russia.	120	83.2
Ikof, '84	Constantinople.	17 crania	74.5
Ikof, '84	Crimea.	30 crania (Karaim).	83.3
Majer and Kopernicki,'85	Galicia.	100	81.7
Jacobs, '90	England.	363	80.0
Jacobs, '90	England (Sephardim).	51	
Talko-Hyrncewicz, '92	Lithuania.	713	
Chantre, '95	Caucasia.	34	85.0
Weissenberg, '95	South Russia.	100	82.5
Weissenberg, '95	South Russia.	50 women.	82.4
Glück, '96	Bosnia (Spagnuoli).	55	80.1
Livi, '96	Italy.	34	81.6
Elkind, '97	Poland.	325	{ Men, 81.9 Women, 82.9
Deniker, '98	Daghestan.	19	87.0

During the last quarter of a century about twenty-five hundred Jews have submitted their heads to scientific measurement. These have naturally for the most part been taken from the Great Russian and Polish branch; a few observers, as Lombroso, Ikof, Jacobs, Glück, and Livi, have taken observations upon a

more or less limited number from southern Europe. For purposes of comparison we have reproduced in our footnote a summary of all the results obtained thus far. Inspection of the table shows a surprising uniformity. Ikof's limited series of Spagnuoli from Constantinople, and that of the Jews from Caucasia and Daghestan, are the only ones whose cephalic index lies outside the limits of 80 to 83. In other words, the Jews, wherever found in Europe, betray a remarkable similarity in head form, the crania being considerably broader than among the peoples of Teutonic descent. As we know, the extremes of head form in Europe, measured by the cephalic index, extend from 74 to 89; we thus observe that the Jews take a place rather high in the European[Pg 341]
[Pg 342] series. They are about like the northern French and southern Germans. More important still, they seem to be generally very closely akin in head form to the people among whom they reside. Thus, in Russia and Poland scarcely an appreciable difference exists in this respect between Jews and Christians. The same is true in Turin, while in the direction of Asia our Jews are as bullet-headed as even the most typical Armenians and Caucasians round about them.



ARAB. Index, 76.

MUSSULMAN, TUNIS. Index, 75.

JEW, TUNIS. Index, 75.

AFRICAN SEMITIC TYPES.

This surprising similarity of head form between the Jews of North and South Europe bears hard upon the long-accepted theory that the Sephardim is dolichocephalic, thereby remaining true to the original Semitic type borne to-day by the Arabs. It has quite universally been accepted that the two branches of the Jews differed most materially in head form. From the facial dissimilarity of the two a correlative difference in head form was a gratuitous inference. Dr. Beddoe observes that in Turkey the Spagnuoli "seemed" to him to be more

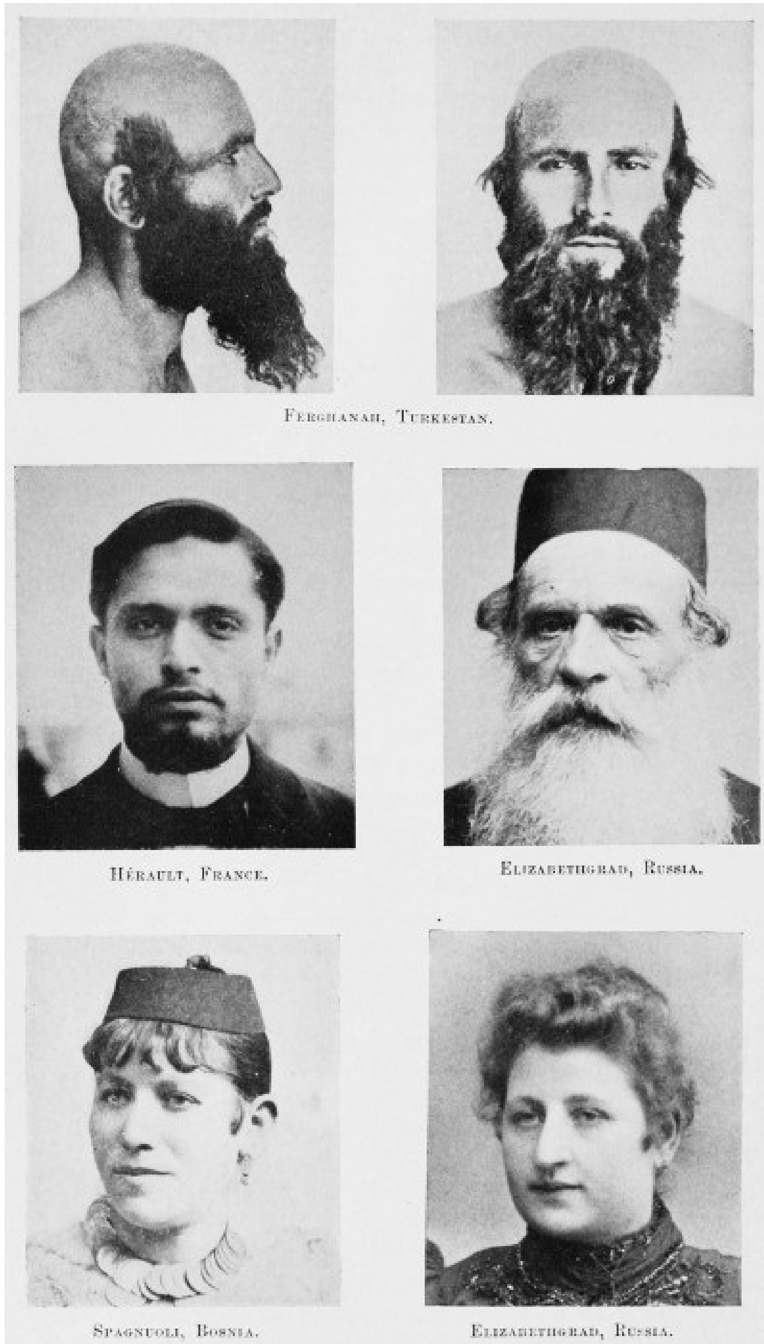
dolichocephalic. A few years later Barnard Davis (1867) "suspected" a diversity, but had only three Italian skulls to judge from, so that his testimony counts for little. Then Weisbach (1877) referred to the "exquisitely" long heads of the Spagnuoli, but his data show a different result. Ikof, with his small series of crania from Constantinople, is the only observer who got a result which accords in any degree with what we know of the head form of the modern Semitic peoples. On the other hand, Glück in Bosnia and Livi in Italy find no other sign of long-headedness than a slight drop in index of a point or two. Jacobs, in England, whose methods, as Topinard has observed, are radically defective, gives no averages for his Sephardim, but they appear to include about eleven per cent less pure long-headed types than even their Ashkenazim brethren in London. This, it will be noted, is the exact opposite of what might normally be expected. This tedious summary forces us inevitably to the conclusion that, while a long-headed type of Sephardim Jews may exist, the law is very far from being satisfactorily established.

Thus, from a study of our primary characteristic—the proportions of the head—we find our modern Jews endowed with a relatively much broader head than that of the average Englishman, for example: while the best living representative of the Semitic race, the Arab, has a head which is even longer and narrower than our own type. It is, in short, one of the longest known, being in every way distinctly African. The only modern Jews who even approach this type would seem to be those who actually reside to-day in Africa, as in the case of our two portrait types from that region. Two possible explanations are open to us: either the great body of the Jews in Europe to-day—certainly all the Ashkenazim, who form upward of ninety per cent of the nation, and quite probably the Sephardim also, except possibly those in Africa—have departed widely from the parental type in Palestine; or else the original Semitic type was broad-headed, and, by inference, distinctly Asiatic in derivation; in which case it is the modern Arab which has deviated from its original pattern. Ikof is the only authority who boldly faces this dilemma, and chooses the Asiatic hypothesis with his eyes open.[19] Which, we leave it to the reader to decide, would be the more likely to vary—the wandering Jew, ever driven from place to place by constant persecution, and constantly exposed to the vicissitudes of life in densely populated cities, the natural habitat of the people, as we have said; or the equally nomadic Arab, who, however, seems to be invariable in type, whether in Algeria, Morocco, the Canary Islands, or Arabia Felix itself? There can be but one answer, it seems to us. The original Semitic stock must have been in origin strongly dolichocephalic—that is to say, African as the Arabs are to-day; from

which it follows, naturally, that about nine tenths of the living Jews are as widely different in head form from the parent stock to-day as they well could be. The boasted purity of descent of the Jews is, then, a myth. Renan (1883) is right, after all, in his assertion that the ethnographic significance of the word Jew, for the Russian and Danubian branch at least, long ago ceased to exist. Or, as Lombroso observes, the modern Jews are physically more Aryan than Semitic, after all. They have unconsciously taken on to a large extent the physical traits of the people among whom their lot has been thrown. In Algiers they have remained long-headed like their neighbors, for, even if they intermarried, no tendency to deviation in head form would be provoked. If, on the other hand, they settled in Piedmont, Austria, or Russia, with their moderately round-headed populations, they became in time assimilated to the type of these neighbors as well.

Nothing is simpler than to substantiate the argument of a constant intercourse and intermixture of Jews with the Christians about them all through history, from the original exodus of the forty thousand (?) from Jerusalem after the destruction of the second temple. At this time the Jewish nation as a political entity ceased to exist. An important consideration to be borne in mind in this connection, as Neubauer suggests very aptly, is that opposition to mixed marriages was primarily a prejudice of religion and not of race. It was dissipated on the conversion of the Gentile to Judaism. In fact, in the early days of Judaism marriage with a nonbeliever was not invalid[Pg 344]
[Pg 345] at all, as it afterward became, according to the Jewish code. Thus Josephus, speaking of the Jews at Antioch, mentions that they made many converts, receiving them into their community. An extraordinary number of conversions to Judaism undoubtedly took place during the second century after Christ. As to the extent of intermarriage which ensued during the middle ages discussion is still rife. Renan, Neubauer, and others interpret the various rigid prohibitions against intermarriage of Jews with Christians—as, for example, at the church councils of 538, 589, at Toledo, and of 743 at Rome—to mean the prevalent danger of such practices becoming general; while Jacobs, Andree, and others are inclined to place a lower estimate upon their importance. Two wholesale conversions are known to have taken place: the classical one of the Khozars, in South Russia, during the reign of Charlemagne, and that of the Falashas, who were neighboring Arab tribes in Yemen. Jacobs has ably shown, however, the relatively slight importance of these. It is probable that the greatest amount of infusion of Christian blood must have taken place, in any event, not so much through such striking conversions, as insidiously through clandestine or

irregular marriages.



JEWISH TYPES.

We find, for example, much prohibitive legislation against the employment of Christian servants by Jews. This was directed against the danger of conversion to Judaism, by the master, with consequent intermarriage. It is not likely that these prohibitions were of much avail, for, despite stringent laws in Hungary, for example, we find the archbishop of that country reporting in 1229 that many

Jews were illegally living with Christian wives, and that conversions by thousands were taking place. In any case, no protection for slaves was ever afforded. The confinement of the Jews strictly to the Ghettos during the later centuries would naturally discourage such intermixture of blood, as also the increasing popular hatred between Jew and Christian; but, on the other hand, the greater degree of tolerance enjoyed by the Israelites even during this present century would be competent speedily to produce great results. Jacobs has strenuously, although perhaps somewhat inconclusively, argued in favor of a substantial purity of the Jews by means of a number of other data—such as, for example, by a study of the relative frequency of Jewish names, by the supposed relative infecundity of mixed marriages, and the like. Experience and the facts of everyday observation, on the other hand, tend to confirm us in the belief that racially no purity of descent is to be supposed for an instant. Consider the evidence of names, for example. We may admit a considerable purity, perhaps, to the Cohns and Cohens, legitimate descendants of the Cohanim, the sons of Aaron, early priests of the temple. Their marital relations were safeguarded against infusion of foreign blood in every possible way. The name is, perhaps, in its various forms, the most frequent among Jews to-day. But how shall we account for the equally pure Jewish names in origin, such as Davis, Harris, Phillips, and Hart? How did they ever stray so far from their original ethnic and religious significance, unless the marital bars were lowered to a large degree? Some of them certainly claim a foremost position numerically in our Christian English directories. We have an interesting case of indefinite Jewish delimitation in our portraits. The middle portrait at page 341 is certainly a Jewish type. Dr. Bertholon writes me that all who saw it immediately asserted it to be a Jew. Yet the man was a professed Mussulman, in fact, even though his face was against him.

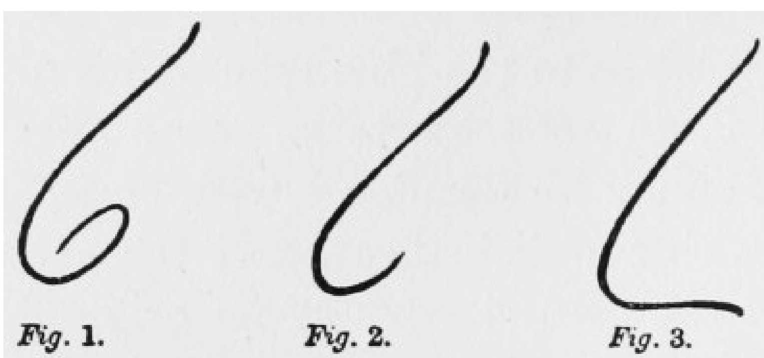
There is, as we have sought to prove, no single uniform type of head peculiar to the Jewish people which may be regarded as in any sense racially hereditary. Is this true also of the face? Our first statement encounters no popular disapproval, for most of us never, perhaps, happened to think of this head form as characteristic. But the face, the features! Is this another case of science running counter to popular belief?

The first characteristic to impress itself upon the layman is that the Jew is generally a brunette. All scientific observers corroborate this impression, agreeing in that the dark hair and eyes of this people really constitute a distinct racial trait. About two thirds of the Ashkenazim branch in Galicia and Russia,

where the general population is relatively quite blond, is of the brunette type, this being especially marked in the darker color of the hair. For example, Majer and Kopernicki,[20] in Galicia, found dark hair to be about twice as frequent as the light. Elkind,[21] in Warsaw, finds about three fifths of the men dark. In Bosnia, Glück's observations on the Sephardim type gave him only two light-haired men out of fifty-five. In Germany and Austria[22] this brunette tendency is likewise strongly emphasized. Pure brunette types are twice as frequent in the latter country, and three times as frequent in Germany, among Jewish as among Christian school children. Facts also seem to bear out the theory, to which we have already alluded, that the Oriental Jews betray a slightly greater blond tendency, thus inclining to rufous. In Germany also the blond tendency becomes appreciably more frequent in Alsace-Lorraine, a former center of gravity of the nation, as the map in our previous article has shown. This comparative blondness of the Alsatian Jew is not new, for in 1861 the origin of these same blondes was matter of controversy. Broca believed them to be of northern derivation, while Pruner Bey traced them from a blondish Eastern source. The English Jews seem also to be slightly lighter than their continental brethren, even despite their presumably greater proportion of Sephardim, who are supposed to be peculiarly dark. As to the relative red blondness of the Oriental Jew, the early observations of Dr. Beddoe, and those of Langerhans (1873) as to the blue eyes and red-brown hair of the Druses of Lebanon, do not seem to be borne out; or, as Jacobs puts it, the "argument may be dismissed with costs." Certainly the living Semites are dark enough in type, and the evidence of the sacred books bears out the same theory of an original dark type. Thus "black" and "hair" are commonly synonymous in the early Semitic languages. In any case, whatever the color in the past, we have seen that science corroborates the popular impression that the Jews as a people are distinctively of a brunette type. This constitutes one of the principal traits by which they may be almost invariably identified. It is not without interest to notice that this brunetteness is more accentuated, oftentimes, among the women, who are, the world over, persistent conservators of the primitive physical characteristics of a people.[23]

Secondly, as to the nose. Popularly the humped or hook nose constitutes the most distinctive feature of the Jewish face. Observations among the Jews, in their most populous centers, do not, however, bear out the theory. Thus Majer and Kopernicki (1885), in their extended series, found only nine per cent of the hooked type—no greater frequency than among the Poles; a fact which Weissenberg confirms as to the relative scarcity of the convex nose in profile among his South Russian Jews. He agrees, however, that the nose is often large,

thick, and prominent. Weisbach (1877) measured the facial features of nineteen Jews, and found the largest noses in a long series of people from all over the earth; exceeded in length, in fact, by the Patagonians alone. The hooked nose is, indeed, sometimes frequent outside the Jewish people. Olechnowicz found, for example, over a third of the noses of the gentry in southeast Poland to be of this hooked variety. Running the eye over our carefully chosen series of portraits, selected for us as typical from four quarters of Europe—Algeria, Russia, Bosnia, and the confines of Asia—representing the African, Balkan Spagnuoli, and Russian Ashkenazim varieties, visual impression will also confirm our deduction. The Jewish nose is not so often truly convex in profile. Nevertheless, it must be confessed that it gives a hooked impression. This seems to be due to a peculiar "tucking up of the wings," as Dr. Beddoe expresses it. Herein lies the real distinctive quality about it, rather than in any convexity of outline. In fact, it often renders a nose concave in profile, immediately recognizable as Jewish. Jacobs[24] has ingeniously described this "nostrility," as he calls it, by the following diagrams: Write, he says, a figure 6 with a long tail (Fig. 1); now remove the turn of the twist, and much of the Jewishness disappears; and it vanishes entirely when we draw the lower continuation horizontally, as in Fig. 3. Behold the transformation! The Jew has turned Roman beyond a doubt. What have we proved, then? That there is in reality such a phenomenon as a Jewish nose, even though it be differently constituted from our first assumption. A moment's inspection of our series of portraits will convince the skeptic that this trait, next to the prevalent dark hair and eyes and the swarthy skin, is the most distinctive among the chosen people.



***Figs.* 1, 2, and 3.**

Another characteristic of the Jewish physiognomy is the eyes. The eyebrows, seemingly thick because of their darkness, appear to be nearer together than usual, arching smoothly into the lines of the nose. The lids are rather full, the eyes large, dark, and brilliant. A general impression of heaviness is apt to be

given. In favorable cases this imparts a dreamy, melancholy, or thoughtful expression to the countenance; in others it degenerates into a blinking, drowsy type; or, again, with eyes half closed, it may suggest suppressed cunning. The particular adjective to be applied to this expression varies greatly according to the personal equation of the observer. Quite persistent also is a fullness of the lips, often amounting in the lower one almost to a pout. The chin in many cases is certainly rather pointed and receding, Jacobs to the contrary notwithstanding. A feature of my own observation, perhaps not fully justified, is a peculiar separation of the teeth, which seem to stand well apart from one another. But a truce to speculations. Entering into greater detail, the flat contradictions of different observers show that they are vainly generalizing from an all too narrow base of observations. Even the fancied differences in feature between the two great branches of the Hebrew people seem to us to be of doubtful existence. Our portraits do not bear it out. It seems rather that the two descriptions of the Ashkenazim and Sephardim types which we have quoted denote rather the distinction between the faces of those of the upper and the lower classes. Enough for us to know that there is a something Jewish in these faces which we instantly detect. We recognize it in Rembrandt's Hermitage, or in Munkaczy's Christ before Pilate. Not invariable are these traits. Not even to the Jew himself are they always a sure criterion. Weissenberg gives an interesting example of this.[25] To a friend, a Jew in Elizabethgrad, he submitted two hundred and fifty photographs of Russian Jews and Christians in undistinctive costume. Seventy per cent of the Jews were rightly chosen, while but ten per cent of the Russians were wrongly classed as Jews. Of what concern is it whether this characterization be entirely featural, or in part a matter of expression? The first would be a matter of direct heredity, the second hypothesis partakes more of the nature of a characteristic acquired from the social environment. Some one—Jacobs, I think—speaks of it as the "expression of the Ghetto." It certainly appears in the remarkable series of composite Jewish portraits published in his monograph. It would not be surprising to find this true. Continued hardship, persecution, a desperate struggle against an inexorable human environment as well as natural one, could not but write its lines upon the face. The impression of a dreary past is deep sunk in the bodily proportions, as we have seen. Why not in the face as well?

We are now prepared, in conclusion, to deal with what is perhaps the most interesting phase of our discussion. It is certainly, if true, of profound sociological importance. We have in these pages spoken at length of the head form—primary index of race; we have shown that there are Jews and Jews in this respect. Yet which was the real Jew it was not for us to decide, for the

ninety-and-nine were broad-headed, while the Semite in the East is still, as ever, a long-headed member of the Africanoid races. This discouraged our hopes of proving the existence of a Jewish cephalic type as the result of purity of descent. It may indeed be affirmed with certainty that the Jews are by hereditary descent from early times no purer than most of their European neighbors. Then we discovered evidence that in this head form the Jews were often closely akin to the people among whom they lived. In long-headed Africa they were dolichocephalic. In brachycephalic Piedmont, though supposedly of Sephardim descent, they were quite like the Italians of Turin. And all over Slavic Europe no distinction in head form between Jew and Christian existed. In the Caucasus also they approximate closely the cranial characteristics of their neighbors. Hypnotic suggestion was not needed to find a connection here, especially since all history bore us out in our assumption of a large degree of intermixture of Gentile blood. Close upon this disproval of purity of type by descent came evidence of a distinct uniformity of facial type. Even so impartial an observer as Weissenberg —certainly not prejudiced in favor of cephalic invariability—confesses this featural unity.

How shall we solve this enigma of ethnic purity, and yet impurity, of type? In this very apparent contradiction lies the grain of comfort for our sociological hypothesis. The Jew is radically mixed in the line of *racial descent*; he is, on the other hand, the legitimate heir to all Judaism as a matter of *choice*. It is for us a case of purely artificial selection, operative as ever only in those physical traits which appeal to the senses. It is precisely analogous to our example of the Basques in France and Spain. What we have said of them will apply with equal force here. Both Jews and Basques possessed in a high degree a "consciousness of kind"; they were keenly sensible of their social individuality. The Basques primarily owed theirs to geographical isolation and a peculiar language; that of the Jews was derived from the circumstances of social isolation, dependent upon the dictates of religion. Another case in point occurs to us in this connection. Chantre,[26] in a recent notable work, has shown the remarkable uniformity in physical type among the Armenians. They are so peculiar in head form that we in America recognize them at once by their foreshortened and sugar-loaf skulls, almost devoid of occiput. They too, like the Jews, have long been socially isolated in their religion. Thus in all these cases, Basques, Armenians, and Jews, we have a potent selective force at work. So far as in their power lay, the individuality of all these people was encouraged and perpetuated as one of their dearest possessions. It affected every detail of their lives. Why should it not also react upon their ideal of physical beauty? and why not influence their sexual

preferences, as well as to determine their choice in marriage? Its results became thus accentuated through heredity. But all this would be accomplished, be it especially noted, only in so far as the physical traits were consciously or unconsciously impressed upon them by the facts of observation. There arises at once the difference between artificial selection in the matter of the head form and that concerning the facial features. One is an unsuspected possession of individuality, the other is matter of common notice and, it may be, of report. What Jew or Christian, till he became anthropologist, ever stopped to consider the shape of his head, any more than the addition of a number of cubits to his stature? Who has not, on the other hand, early acquired a distinct concept of a Jewish face and of a distinctly Jewish type? Could such a potent fact escape observation for a moment?

We are confirmed in our belief in the potency of an artificial selection, such as we have described, to perpetuate or to evolve a Jewish facial type by reason of another observation. The women among the Jews, as Jacobs[27] notes, in confirmation of our own belief, betray far more constantly than the men the outward characteristics peculiar to the people. We have already cited Weissenberg's testimony that brunetteness is twice as prevalent among Russian Jewesses as among the men. Of course this may be a matter of anabolism, pure and simple. This would be perhaps a competent explanation of the phenomenon for physiologists like Geddes and Thompson. For us this other cause may be more directly responsible. Artificial selection in a social group, wherein the active choice of mates falls to the share of the male, would seem to tend in the direction of an accentuated type in that more passive sex on which the selective influence directly plays. At all events, observations from widely scattered sources verify the law that the facial individuality of a people is more often than otherwise expressed most clearly in the women. Thus, for example, the women betray the Mongol type more constantly than the men among the Asiatic tribes of eastern Russia.[28] On the other hand, Mainof, best of authority, confirms the same tendency among those of Finnic descent.[29] The *Setti Communi* in northern Italy still preserve their German language as evidence of a historic Teutonic descent. They seem to have lost their identity entirely in respect of the head form,[30] but Ranke[31] states that among the women the German facial type constantly reappears. This, I confess, is not altogether easy to understand, unless the Lombards, of whom these colonies are supposedly the remnants, brought their native women with them across the Alps. Perhaps, however, not bringing their women, a new Teutonic resemblance has been evolved out of whole cloth. A better example than this is offered among the Hamitic peoples of Africa north

of the Sahara. These peoples, from Abyssinia to Morocco, really belong to the white races of Europe. Among nearly all their tribes the negroid traits are far more accentuated among the women, according to Sergi.[32] It is not necessary to cite more specific testimony. The law occupies a respected place among anthropologists. That the Jews confirm it, would seem to strengthen our hypothesis at every point.

Our final conclusion, then, is this: It is paradoxical, yet true, we affirm. The Jews are not a race, but only a people, after all. In their faces we read its confirmation, while in respect of their other traits we are convinced that such individuality as they possess—by no means inconsiderable—is of their own making from one generation to the next, rather than as a product of an unprecedented purity of physical descent.

TRUE TALES OF BIRDS AND BEASTS.

By DAVID STARR JORDAN.

I.—SEÑOR ALCATRAZ.

He was just a bird when he was born, and a very ugly bird at that. For he had big splay feet, with all the toes turned forward and joined together in one broad web, and his wings were thick and clumsy, and underneath his long bill there was a big red sack that he could fill with fishes, and when it was full he could hardly walk or fly, so large the sack was and so great was his appetite.

But he kept the sack well filled and he emptied it out every day into his stomach, and so he grew very soon to be a large bird, as big as a turkey, though not as fat, and each day uglier than ever.

But one morning, when he was walking out on the sand flat of the Astillero at Mazatlan, Mexico, where he lived, he saw a big fish which had been left by the falling tide in a little pool of water. It was a blue-colored fish with a big bony head, and no scales, and a sleek, slippery skin. He did not know that it was a *bagre*, but he thought that all fishes were good to eat, so he opened his mouth and slipped the fish, tail first, down into his pouch. It went all right for a while, but when the fish woke up and knew he was being swallowed, he straightened out both of his arms, and there he was. For the bagre is a kind of catfish, and each arm is a long, stiff, sharp bone, or spine, with a saw edge the whole length of it. And all the bagre has to do is just to put this arm out straight and twist it at the shoulder and then it is set, and no animal can bend or break it. And it pierced right through the skin of the bird's sack, and the bird could not swallow it, nor make it go up nor down, and the bagre held on tight, for he knew that if he let go once he would be swallowed, and that would be the last of him.

So the bird tried everything he could think of, and the fish held on, and they kept it up all day. In the afternoon a little boy came out on the sands. His name was Inocente, and he was the son of Ygnacio, the fisherman of Mazatlan. And Inocente took a club of mangrove and ran up to the struggling bird and struck it on the wing with the club. The blow broke the wing, and the bird lay down to die, for with a broken wing and a fish that would not go up nor down, there was

no hope for him.

When Inocente saw what kind of a fish it was, he knew just what to do. He reached down into the bird's sack and took hold of the fish's spines. He gave each one a twist so that it rolled over in its socket, the upper part toward the fish's head, and then they were not stiff any more, but lay flat against the side of the fish, just as they ought to lie. Then the fish knew that it had found a master, and lay perfectly still. So the bird gave a great gulp, and out the bagre went on the sand, and when the tide came up it swam away, and took care never to go again where a bird could get hold of it. And the bird with the broken wing had learned something about fishes, too. But he could not fly away, so he waited to see what the boy was going to do.

The boy took the bird into his boat and brought him home. And old Ygnacio put a splint on his wing and covered it with salve, and by and by it healed. But the bone was set crooked, and the bird could not fly very well. So the boys called the bird Señor Alcatraz, which is the Spanish for Mr. Pelican, and Señor Alcatraz and all the boys and dogs and goats became good friends, and all ran about on the streets together. And when the boys would shout and the dogs bark, all Señor Alcatraz could do was to squawk and hiss and open his big mouth and show the inside of his red fish sack.

And when the boys would go fishing on the wharf, Alcatraz would go, too, and he would stow away the fishes in his pouch as fast as the boys could catch them. But if they caught a bagre fish, he would turn his head the other way and then run away home just as fast as his splay feet would take him.

And when the men drew the net on the beach Alcatraz would splash around inside the net, catching whatever he could, and having a great deal of fun in his clumsy pelican fashion. Then he would run along the street with the boys, squawking and flapping his wings and thinking that he was just like the rest of them. And if you ever go to Mazatlan, ask for Dr. Rogers, and he will show you the way to Ygnacio's cabin on the street they call Libertad. And there in the front yard, in a general scramble of dogs, goats, and little Indian boys, you will see Señor Alcatraz romping and squabbling like the best of them. And you will know which he is by the broken wing and the red sack under his throat. But if you say "Bagre" to him, he will run under the doorstep and hide his face till you go away.

II.—THE LITTLE BLUE FOX.

Once there was a little blue fox, and his name was Eichkao, and he was a thief. So he built his house down deep among the rocks under the moss on the Mist Island, and his little fox children used to stay down among the rocks. There they would gurgle, gurgle, gurgle, whenever they heard anybody walking over their heads. Eichkao and his fox wife used to run all round over the rocks to find something for them to eat, and whenever Eichkao saw anybody coming he would go clin-n-n-g, cling-g-g, and his voice was high and sharp, just like the voice of a buzz saw.

One day he walked out on the rocks over the water and began to talk to the black sea parrot, whose name is Epatka, and who sits erect on his carelessly built nest with one egg in it, and wears a great big bill made of red sealing wax. He has a long white quill pen stuck over each ear, and over his face is a white mask, so that nobody can know what kind of a face he has, and all you can see behind the mask is a pair of little foolish twinkling white glass eyes. What the two said to each other I don't know, but they did not talk very long, for in a few minutes when I came back to his house among the rocks Eichkao was gone, and there lay out on the bank a bill made of red sealing wax, a white mask, and two little white quill pens. There were a few bones and claws and some feathers, but they did not seem to belong to anything in particular, and the little foxes in the rocks went gurgle, gurgle, gurgle.

One day I lay down on the moss out by the old fox walk on the Mist Island, and Eichkao saw me there and thought I was some new kind of walrus which might be good to eat, and would feed all the little foxes for a month. So he ran around me in a circle, and then he ran around again, then again and again, always making the circle smaller, until finally the circle was so narrow that I could reach him with my hand. As he went around and around, all the time he looked at me with his cold, gray, selfish eye, and not one of all the beasts has an eye as cruel-cold as his. When he thought that he was near enough, he gave a snap with his jaws, and tried to bite out a morsel to take home to the little foxes; but all I offered him was a piece of rubber boot. And when I turned around to look at him he was running away as fast as he could, calling klin-n-g-g, klin-n-g, klin-n-g, like a scared buzz saw all the time as he went out of sight. And I think that he is running yet, while the little foxes still go gurgle, gurgle under the rocks.

III.-HOW THE RED FOX WENT HUNTING.

(*With acknowledgment to Mr. A. C. Bassett, of Menlo Park, California.*)

Once on a time there was a great tall rabbit, the kind the miners call a "narrow-gauge mule"; but he was not a mule at all, and his real name was "Jack Rabbit." His home was in Montana, and he lived by the river they call the Silver Bow. He could run faster than any of the other beasts, and he went lickety-clip, lickety-clip, bounding over the tops of the sagebrush, for he had no brush of his own to carry.

And there was a red fox who lived on the Silver Bow, too, and he went hunting because he wanted rabbit for dinner. But while he could run very fast he could not bound over the tops of the sagebrush, for his own brush, which he always carried with him because he was so proud of it, would catch on the thorns of the other kinds of brush and so would keep him back.

So he sent for his cousin, the coyote, to come and help him. Now, the coyote lived out in the country by Emigrant Mountain. He was not proud at all, for he hadn't much of a brush, and nobody flattered him for his beauty. But for all that the coyote could run very fast, as he had Indian blood in him. The only trouble was that his hind feet ran faster than his fore feet. So he had to stop every little while and run sidewise to unkink himself and give his fore feet a chance to catch up.

When the coyote came up the rabbit was bounding along through the bushes, going around in a great circle so that he always came back to the same place, for that is the way of the rabbit-folk. So the fox lay low and hid his brush in the sage, and the coyote followed the rabbit around the circle. And he just kept up with the rabbit all the way, for the rabbit wasn't scared, and didn't run very fast. And when they had gone once around the circle the rabbit passed the hidden fox. Then the fox got up and chased him, and was only a few feet behind. And the coyote stopped and ran sidewise for a while to unkink himself, and then he lay down in the bushes and waited for the rabbit to come back. The rabbit was much scared when he saw the fox close behind him, so he ran and bounded very fast, and the fox kept falling behind because he had his long brush to carry. But he kept at it just the same, and when the rabbit came around the circle to where he started there was the coyote waiting for him. The rabbit had to make a great jump to get over the coyote's head. Then they went around again and the coyote kept close behind all the way, and the rabbit began to get tired. When the coyote's hind legs got tangled up then the fox was rested, and he took up the chase; and so they kept on, each one taking his turn, except the rabbit, who had to keep his own turn all the time.

When the race was over there was nobody there to see how they divided up what they caught. But I saw the coyote the next day, and he looked so very empty that I think that the red fox must have taken all the rabbit meat for himself. Most likely he left his cousin just the ears for his part, with a rabbit's foot to carry in his pocket for good luck.

GLACIAL GEOLOGY IN AMERICA.

By Prof. DANIEL S. MARTIN.

Under this title the vice-president of Section E (Geology) of the American Association—Prof. Herman L. Fairchild, of the University of Rochester, New York—gave an admirable *résumé* of the whole history, progress, and scope of the study of ice phenomena in North America, as the opening address before the section at the recent Boston meeting. Apart from the interest of the subject in itself considered, this address was a model of what such addresses should be. While strictly scientific, without the least attempt at rhetorical effect, it was at the same time so clear, so well arranged and so simple in language, that any intelligent auditor could enjoy it and grasp it, and carry away a distinct impression of the gradual development and present status of this great department of geological study. Professor Fairchild's choice of his subject was happy also in its fitness to the occasion, as covering almost exactly the half century of the life of the association, though going back indeed a few years further, into the period of the earlier society which developed into the association in 1848.

The great body of phenomena comprised under the term "drift," and the smoothed and scratched surfaces of rock, etc., had been by no means unnoticed by the early students of American geology, but they were attributed to violent and widespread water action, and were spoken of in general as "diluvial" formations. When the agency of ice began to be recognized, it was regarded as that of floating and stranding bergs; and this view for a long time contended with the theory of glacial action, even when the latter had been adopted and advocated by eminent students of the subject.

The first allusion to drifting ice as the agent of transportation of bowlders, etc., appears to have been made as early as 1825, by one Peter Dobson, of Connecticut, in a letter to Prof. Benjamin Silliman, of Yale College. Sir Roderick Murchison, who became the great champion of this view, credits Mr. Dobson's letter with giving him the first suggestion of it. Twelve years later, in 1837, T. A. Conrad made the earliest reference to land ice as the cause of our drift phenomena; he does this in very striking words when read in the light of the studies and determinations of later years, although of course imperfectly and

vaguely.

Meanwhile, however, Agassiz and others had been working among the glaciers of the Alps, and their views as to a great period of former extension, in Europe and the British Isles, were finding some acceptance abroad. In this country, Prof. Edward Hitchcock, in his address as retiring president of the Association of American Geologists, in 1841, gave a broad and careful review of the drift phenomena in eastern North America, and referred to the work of Agassiz, Buckland, and Lyell with great interest, as having given him "a new geological sense" in observing these phenomena, and said, with prophetic foresight, "Henceforth, glacial action must form an important chapter in geology."

But the time was not ripe for the understanding and acceptance of the glacial theory as a later generation has come to know it. The studies of Agassiz and his *confrères* had been among glaciers upon mountain slopes, and hence, while many of the drift phenomena were strikingly accounted for, others were not and could not be. So it came to pass that, while Professor Hitchcock and others in this country were strongly impressed, they were not satisfied, and held for years an uncertain position. The glacial indications conformed in some aspects to the theory, but not in others; the striæ and groovings, instead of following valleys, all had a general trend to the southward, and the bowlders were carried across great depressions and deposited upon heights. How could these conditions be due to glaciers? Could ice flow uphill, or move long distances over level areas? These and other phenomena, such as the peculiar distribution of drift material, in "drumlin" ridges and the like, had no explanation. Hence, notwithstanding President Hitchcock's utterances above quoted, and his similar Postscript on the subject of drift and moraines, appended in the same year to his volume on the Geology of Massachusetts, we find him in 1843, when again addressing the Association of Geologists, adopting a modified tone, dwelling upon these points of difficulty, and seeking a compromise view, which he called "glacio-aqueous." The great influence also of Murchison and Lyell had been thrown into the scale in favor of the iceberg theory, and this fact doubtless had much to do with the slow development of true conceptions. Lyell visited America in 1842, and was present at the American Geologists' meeting, advocating the floating-ice doctrine, to which most of our observers already leaned; and so the views of Agassiz and the glacial school had to wait for a decade before they found general acceptance or even audience.

This, we may note in passing, is but one marked instance out of many in the history of science, wherein the personal influence of eminent leaders has

obstructed and retarded the advance of true knowledge. The whole recognition of the Cambrian system, as pre-Silurian and distinct, was suppressed and prevented for many years by Murchison's intense opposition to the views of Sedgwick. Similar facts might be cited in this country, did we care to mention names. Science can not claim, as is sometimes asserted, that it possesses or imparts any entire exemption from the influence of authority, and bestows complete independence from the tendency to "swear to the words of a master."

Of the New York geologists, Vanuxem alone, in his Geology of the Third District, 1842, inclined to the glacial theory; the others—Emmons, Mather, and Hall—advocated floating ice, the latter urging as a chief objection the absence of any great northern highlands from which glaciers could extend southward. Prof. Henry D. Rogers advocated De la Beche's view, of great catastrophic waves or *débacles* of water and ice, produced by sudden uplifts of the floor of a circumpolar ocean, and sweeping southward with tremendous power over the middle latitudes. These views were presented by him in 1844, at the Washington meeting of the geologists, and are to us a most curious illustration of the old "cataclysmic" phase of geological conceptions.

Two years later Agassiz came to America, and at once set about studying the ice evidences here, first in the White Mountains and then around the Great Lakes. At the first meeting of the American Association, in 1848, he presented his views as to the identity of our phenomena with those studied by himself, Desor, and Guyot abroad. His views were not very warmly received, however, and he did not attempt their public presentation again for some years, turning his attention more to the field of zoölogy. In 1850, in a work on Lake Superior, he refers somewhat sharply to the prejudice that seemed to prevail in relation to this subject.

From this time, however, the aqueous theories began to be less strongly presented; and a new generation of geologists was coming on, largely under the training of Guyot and Agassiz, and more open to their observed results. C. B. Adams, in 1850, presented a view nearly akin to that adopted by Dana a few years later, of an elevation of the high northern latitudes, resulting in a southward-moving glacial sheet, and a subsequent depression connected with its retreat, to account for the stratified deposits. Professor Dana accepted this doctrine in his presidential address before the association in 1855, adding the "Terrace period" of partial re-elevation. From this time he became the leader of the American glacialists, and his great Manual, issued in 1862, carried these views into all the colleges of the country.

In 1857 Prof. Edward Hitchcock published an important treatise on Surface Geology, particularly of the Connecticut Valley, in the Smithsonian Contributions to Knowledge. In this paper he noted the distinction, so important and now so familiar, between local striæ and those with the general southward course of the "drift." Two years later his son, Prof. C. H. Hitchcock, extended this distinction widely over New England. In 1863 the report of progress of the Geological Survey of Canada gave an extended review of the surface geology, by Prof. Robert Bell, in which he fully adopted the glacial theory. Meantime, also, Professor Ramsay, in England, had abandoned the iceberg doctrine for that of glaciers.

In 1866 and 1867 important papers appeared by Charles Whittlesey, and one by Edward Hungerford; this last, read before the association, adopted the general views of Agassiz, with some important limitations now generally received. In the same year the revised edition of Dana's Manual gave yet fuller statement and wider diffusion to the generally accepted views as held to-day.

Professor Fairchild sums up this historical sketch as comprising four periods—viz., prior to 1841, undisputed reign of diluvial hypotheses; 1841 to 1848, suggestion and discussion of glacial hypotheses; 1849 to 1866, gradual acceptance of the latter view; from 1867 onward, development of glacial geology.

From this point, the address was occupied with consideration of the various aspects of the subject as studied and wrought out during the past twenty years by numerous observers. These are grouped under four main heads, each with various subdivisions—viz., (1) the ice sheet, as to its area, its thickness, its centers of dispersion, its migration of centers, etc.; (2) the ice period, as to its cause, its divisions, its duration, its distance in time; (3) the interpretation of special phenomena, such as moraines, drumlins, eskers, "kettles," and the like, valley drift, terraces, loess, etc.; and (4) existing glaciers, as discovered on our high mountains of the far West, and as studied in closer relation to the ancient phenomena in the great ice cap of Greenland and the immense glacier development in Alaska.

It is impossible to go into a detailed review of the numerous points of interest covered in this discussion. Suffice it to say that one who heard or who reads it finds an admirably clear and condensed account of all the problems and phenomena that have been and that are now encountered in the study of glacial geology on this continent, and of their gradual interpretation and solution by the

combined labors of many students. The progress of knowledge over this wide field, advancing step by step, amid conflicting views and perplexing conditions, is beautifully shown, and leaves a very striking impression on the mind, of the difficulties and the successes of scientific research. Nor is Professor Fairchild disposed to claim too much or assert too strongly. He recognizes that, with all that has been met and mastered, there are still questions unsolved, and laurels to be won by others.

Among the facts brought out, a few may be briefly alluded to. The early abandonment of Agassiz's original view of a vast extension of the polar snow caps, and the recognition of separate centers of continental glaciation, now distinctly determined as three in number—a western, a central, and an eastern—the former being the earliest, and the others following in succession; the recognition by the Western geologists of the twofold character of the Glacial epoch, as also determined in western Europe, but less markedly traceable in our Eastern States, though now generally admitted; in close relation to this the determination of the line of the great terminal moraine, traced by successive observers from the Atlantic seaboard to Minnesota, and the subsequent recognition of an older, eroded, and fragmentary morainal "fringe," marking the line of the earlier ice sheet, somewhat beyond the later. With regard to the actual distance of the last glacial retreat, as expressed in years, Professor Fairchild is both cautious and frank. He notes the general consensus of recent observers toward a much shorter period than was formerly supposed—from five to ten or perhaps fifteen thousand years. At the same time, there are many elements of uncertainty involved, and the problem is by no means settled. The Niagara gorge, so long looked upon as a possible chronometer, grows more complicated as it is further studied; the rate of erosion has evidently varied much with the volume of water carried by the river; and this, in turn, has varied with the changes of level, and consequently of drainage routes, in the basin of the Great Lakes. There have been times when only the Erie waters flowed through the Niagara outlet, the upper lake drainage passing eastward independently, until a gradual northern rise of the land, which is proved to be still going on, turned the entire drainage into the present St. Clair route from Lake Huron into Lake Erie, and so through Niagara.

This point leads us to digress for a moment from the address under consideration to allude to a very interesting department of study that is now growing into prominence—to wit, the restoration of pre-glacial geography and hydrography, and the genesis of our existing river and lake systems throughout the northern part of the country. The discussions and results in regard to Niagara and the Great Lakes are somewhat familiar, but the work on the rivers and smaller lakes is not so widely known. Professor Fairchild himself has done much in relation to the "central lakes" of New York State; and one very interesting paper of this kind on The Development of the Ohio River was read before the section by Prof. William G. Light, of Granville, Ohio, besides many papers by others on similar topics.

The work done within a few years upon the glaciers of Arctic America has proved peculiarly fruitful in results. Here, again, the whole subject is reviewed historically, and the name and work of each observer are impartially noted. Much of the difficulty encountered by the glacial theory arose, as we have seen, from the fact that only mountain glaciers had been studied, so that many of the phenomena produced by continental ice could not be explained. Professor Fairchild says, as to this aspect: "More has been learned of the structure, behavior, and work of our ancient ice sheets by the study of the Alaskan glaciers during the last ten years, and especially by the study of the Greenland ice cap during the last four years, than by all the study of the Alpine glaciers for the seventy years since they have been observed." Prominent among those who have worked in this field are the names of Professors Chamberlain and Salisbury in Greenland, and Professors H. F. Reid and I. C. Russell in Alaska; other important contributors are Prof. W. P. Blake, the pioneer geologist in Alaska, 1867; Dall and Baker, who discovered and named the Malaspina Glacier in 1874; and John Muir, 1878, for whom the Muir Glacier was named; Wright, Baldwin, Schwatka, Libbey, and others, and Barton and Tarr in Greenland.

Professor Russell, in 1891, recognized and named a type of glacier that was before unknown. In his studies on the Malaspina he found a condition that does not occur, so far as yet observed, anywhere else than on the northwest coast of America; this is where a number of mountain glaciers debouch upon a low, flat coast plain, and unite to form a great sluggishly moving sheet of ice. This particular development he called the Piedmont type.

In closing his address, Professor Fairchild remarks that the word "theory," as applied to the glacial origin of the drift and its phenomena, may and should now

be abandoned. The subject has passed beyond the stage of theory, and is as well understood and as clearly established as the volcanic origin of the cone of Vesuvius or the sedimentary origin of stratified rocks.

In the center of the artificial platforms or platform mounds, characteristic of many of the ancient Peruvian towns, Mr. Bandelier has observed features that recall forcibly the New Mexican Indian custom of giving to each inanimate object its heart. In some instances, says Mr. F. W. Hodge, in his paper, round columns formed a kind of an interior niche; in others, a small chamber contained urns or jars with maize meal. A remarkable and very significant feature was observed by the explorer in a partly ruined mound at Chanchan. The core of this structure when opened showed two well-preserved altars of adobe. In such interior apartments, figurines of metal, clay, or wood are almost invariably found; and the materially valuable finds made in Peruvian ruins in earlier times came from the "heart" of one or the other of the artificial elevations described.

MODERN STUDIES OF EARTHQUAKES.

By GEORG GERALAND.

The investigation of earthquakes, seismology, has become in the present day an independent subject of scientific interest. In lands where earthquakes are frequent, as in Italy and Japan, seismic observations have been officially systematized over the whole country, with central and branch stations at which the work is never still. A net of seismic observations of all nations is being more and more closely woven over the whole earth, and there are yearly and monthly collations of observations of even the slightest shocks. Seismic literature is, therefore, nearly inexhaustible, and theory and praxis are in constant vogue; in short, seismics has grown to be a separate branch of science, and to demand independent treatment, calling for the energy and labor of many students. What gives it so great importance? What is the condition of our present knowledge and its history? What will be reached in the future through the competition of the nations? These questions possess a high scientific as well as culture-historical interest. We here attempt to answer them.

The first really scientific description of an earthquake—that of Lisbon—with its far-reaching accompanying phenomena, was the work of the greatest contemporary thinker, Kant, and it is not too much to say that his paper opened a new epoch in the knowledge of earthquakes. That terrible event and the extreme terror which it caused everywhere were followed in 1783 by the likewise extremely destructive earthquake of Calabria. The attention of the people was thus directed to this mysterious mighty activity of the earth, and was kept especially lively in Italy, the country of Europe most subject to earthquakes. The newly rising science of geology therefore found in the last third of the last century in these phenomena a problem of prominent importance. Geologists were the first to apply themselves to seismic studies, as the most widely current explanation of the phenomena is still a geological one. The scientific interest of the question prevailed over the practical. More attentive observation was given to earthquakes, the accounts of them scattered through the ancient chronicles were collated, and the already very numerous seismic notes of great earthquake manifestations—such as those by Hoff, Perry, Mallet, Volger, Fuchs, etc.—constituted a very important factor in the study. One of the earliest results of the inquiry was to show that directly perceptible earthquakes are not perceptible

everywhere; that they are most common on the great upfoldings of the earth's crust on the mountain chains, such as the Andes, Alps, and Himalayas; and that, further, they are connected with the shores of the Pacific, the Antilles, and the Mediterranean, and with places also where great breaches and various disturbances are evident; that they are at home likewise in volcanoes; and that they are most frequent in the northern hemisphere, and when the earth is nearest to the sun. The descriptions of powerful shocks furnish us evidence of a double movement of the earth's crust—an alternate up-and-down vibration and an often very marked wave motion. The destruction which earthquake shocks and waves inflict on buildings, and the remarkably rapid and wide spread of the tremblings over the surface of the earth, have been very diligently inquired into; and when, in 1856, Naples and Calabria were visited by a great earthquake, an English investigator, Robert Mallet, made a full study of it, and believed that by comparing the direction of the rents in walls and buildings, which were assumed to correspond with that of the tremblings, he could identify the focus of the shocks in the earth's interior, and the course of the wave movement over its surface—a view which has long prevailed in seismology. Still more important was the work of the geologist Karl von Seebach, of Göttingen, on the great earthquake in central Germany, which kept the northern part of the plains of the upper Rhine, around Mayence, Grossgerau, and Darmstadt, disturbed for several years after 1869. Von Seebach's chief effort was to obtain the most exact data possible as to the time of the beginning of the shocks from as many places as possible, from which he might deduce the spot where the shocks began and were strongest, the epicenter which lay directly over the point in the earth's interior where the movement originated. From them he also deduced a series of localities where the shocks were simultaneous and of equal intensity, which could be connected by certain nearly circular lines called *homoseists*. As the distance of these from the epicenter increases, the undulations take place later and are weaker, and facts may be thus furnished from the velocity of propagation of the shocks can be computed. The observations are also important because von Seebach undertook through a simple mathematical calculation to determine from them the situation of the forces of the subterranean point where the undulations originated.

With these investigations, the process of annihilating time and space by steam and the applications of electricity was also going on. By the effect of this great event, the conditions of earthquake investigation were revolutionized. A comparative study of the phenomena, fundamental and essential to a science of seismology, on the basis of material furnished from all the regions of the earth,

was rendered possible. An earthquake service was organized in Japan, by J. Milne, of England; one had already been organized for a considerable time in Italy, and the results obtained at the two places of observation so widely separated corresponded. Japanese, Indian, and American earthquakes could be simultaneously studied in Italy, Russia, Germany, and England; and thus a new, hitherto undeveloped field was gained, the scope of which has already extended far beyond its merely geological aspect.

This could have happened only through another advance that has been made in our century, which has first rendered a real seismology, a scientific knowledge of the seismic conditions of the earth, possible through the immense development of technics, by which a system of instrumental observation of earthquakes was established. Only through this could the acquisitions of recent times be utilized. While formerly observations were macroscopic and touched only earthquakes that could be directly felt, they now cover essentially microscopic tremors of the earth's crust, of less than a thousandth of a millimetre, that are wholly imperceptible to human senses; and we can read them, enlarged at our pleasure, on our photographically registering seismometers. We already had instruments which correctly indicated the time of the beginning and possibly the direction of a shock; but we needed and have invented new instruments—various sorts of horizontal and vertical pendulums—for the observation and representation of the whole course of the movement. The vertical indicating instruments are much used in Italy, and the horizontal ones almost exclusively in England, Japan, and Germany. The horizontal pendulum was invented in Germany in 1832 by Hengler, adapted to scientific use by Professor Zöllner, of Leipsic, and afterward applied in that form by English, German, and other observers. The most complete shape and the one best adapted to extremely delicate seismic observations was given to it by the late German astronomer and geographer Dr. Ernst von Rebeur Paschnitz, of Merseburg. Having undergone a few small changes, fixed in a threefold combination it serves as our most sensitive and accurate seismometer. Its movements and its very exact time markings are photographically represented. The pendulum box is only forty centimetres in diameter. In consequence of its convenience and cheapness, its self-action and its serviceability, it is becoming adopted more and more generally as an international instrument.

Microseismic investigation and its wide extension over the earth have raised seismology another step during the last twenty years, so that it may be said that really exact seismic research began with it. Modern seismology has confirmed

many of the older results, such as the localization of earthquakes on the shores of the Pacific, the Mediterranean and in the mountain chains of the earth, and also the importance of homoseists and the epicenter. It has, on the other hand, greatly modified the former estimates of the velocity of propagation of the shocks. It has cast much doubt on speculations as to the seasons in which earthquakes are more or less frequent; and it has demonstrated the inadequacy of former methods of determining the central focus. It has furthermore brought us much that is new. First is the momentous fact that the earth's crust is never at rest; that it undergoes a multitude of very diversified movements besides those of the earthquake. Thus a periodical swelling, a flood wave, is produced by the attraction of the moon; and other heavings are induced by the daily and annual course of the sun's heat. But such movements and other similar ones do not come within the scope of this article.

Real earthquakes, or movements that originate in the depths of the earth, also appear in very different forms. First are the directly perceptible shocks, from the powerful ones that create great disturbances to the merely local ones often hardly remarked. Of the immediate workings of these shocks, microscopic instruments have taught us nothing essentially new. But very many macroscopic movements, often continuing for several hours, but which are not felt, have been revealed, that have been shown in many instances to be distant effects of other strong earthquakes; effects which are sometimes propagated over the whole surface of the earth. There is, furthermore, another series of movements, only partly explained as yet, of a peculiar sort: first, small, quickly passing disturbances, which appear in the photographic reproductions of the curves as larger or smaller knots, and which are regarded with great probability as distant effects of minor seismic movements most likely imperceptible anywhere. They can not be local earthquakes, for they give entirely different curves. There also appear, with considerable regularity, at certain seasons of the year, very slow movements of the ground, called pulsations; and finally the multitude of vibrations called tremors, which assume various forms. Sometimes they come as forerunners, accompaniments, or followers in close association with those great disturbances that originate in distant earthquakes; sometimes as shocks of minute intensity in separate groups, which it has not yet been possible to account for; and in other cases they are traced to the shaking of the ground by the wind. It is hardly necessary to observe that the seismic apparatus should be most carefully guarded against disturbance by the movements of trade, wagons, etc., so that the problem shall not be complicated by them.

The theory of the nature of earthquake shocks, their transmission and their velocity, has been set in a new light by the labors of Augustus Smith, of Stuttgart. From some calculations of their velocity made by G. von Nebeur, it is found that the earthquake of April 17, 1889, in Tokio, Japan, was perceived in Potsdam, Prussia, nine thousand kilometres distant, in thirteen minutes; that of October 27, 1894, in Santiago, Chili, in Rome, eleven thousand five hundred kilometres distant, in seventeen minutes, and in Charkow, Russia, two thousand kilometres from Rome, between one and two minutes later. It reached Tokio at the same time, after a transit of seventeen thousand four hundred kilometres.

Still another task of modern seismology is the investigation of earthquakes at sea, or seismic movements of the bottom of the ocean, and the manner in which they are propagated through the water, of which a very fine cartographic representation has been published by Dr. C. Rudolph, of Strasburg.

The question of the origin of earthquakes stands in constant connection with this external development of seismology. It is significant and remarkable that the answers to it, though they may be given differently from different scientific points of view, are always consistent in one fact, that earthquakes are a phenomenon of the whole earth. Some of the investigators seek to explain them, aside from those that occur in volcanic regions, as a part of the great changes in the earth's crust which have taken place during the last geological epoch, and are still, perhaps, taking place; others find their seat and cause in the unstable condition of the interior of the earth, beneath its solid and red-hot envelope. The former explanation, the older and heretofore the prevalent one, is called the tectonic theory, because it is based, leaving out volcanic earthquakes, on the structure of the earth's crust; the second, which is gaining ground, and requires no separate explanation for volcanic earthquakes, may be called, reviving an expression used by L. Fr. Naumann, of Leipsic, the Plutonic theory, because it goes down into the unexplored depths of the earth. If seismic manifestations depend upon the action of the whole earth, a single explanatory principle, as is always the case with great natural phenomena, is not sufficient, and tectonic as well as Plutonic earthquakes must be recognized, and the reverse.

The tectonic theory is of geological origin, and properly supplanted the older Plutonic theory of Humboldt, which was only an unverified supposition. As a whole it was first worked out by Otto Volger in 1858, after various similar hypotheses had been set forth by other investigators. He was confirmed by the independent researches of Rudolf Hoernes, Edouard Suess, and most of the German, French, and English seismologists.

Their theory supposes that there are large hollow spaces in the crust of the earth, into which immense falls of material take place, and that these are the cause of a part of the earthquakes; that the crust of the earth is often and variously disturbed in consequence of the constant contraction dependent upon the cooling of the globe. It is broken up into separate masses which in their turn are dislocated horizontally or vertically; is lifted up and folded into immense mountain ranges, the arches of which, breaking, may again suffer dislocation. Thus continuous action in movement of masses and foldings is constantly going on in the earth. Edouard Suess, the distinguished Austrian geologist, has indeed constituted a special earthquake type to correspond with this type of mountain formation. Since, in consequence of this condition, tension is present everywhere in the crust of the earth, it may come to pass that it shall be relieved by a distant earthquake, and another earthquake, which may be called a relay or transmission earthquake, be produced thereby. Hence we have, besides the volcanic, the landfall, the tectonic (in the strict sense), and the transmission earthquakes. The sources of earthquake force lie, then, according to this theory, in the incompleteness of the earth's crust, the effects of gravity, and the earth's loss of heat.

And is the supposition not very probable? Do we not see similar processes going on over the whole earth, in the shape of earthquakes, landslides, fissures, subsidences of land, and the like? And as the Alps were lifted up, and the plain of the Rhine was depressed between the Vosges and the Black Forest, may not mightier dislocations, breaches, and destruction occur? Why may not the processes which took place in the earlier epochs of the earth's history and were so powerful in the more recent Tertiary be still going on? All this seems so plausible that, with a few exceptions, the theory has been almost universally agreed in.

I briefly mention here Falb's theory, which, accepting the earlier views, ascribes earthquakes to periodical swellings of the fiery fluid interior of the earth, only because of the effect it has had on the public in connection with some wholly unscientific predictions. More worthy of consideration is the theory of Daubrée, the late distinguished master of French and especially Alsatian geology, who did not attribute the similar phenomena of volcanic and nonvolcanic earthquakes to different causes, but maintained that all earthquakes were produced by superheated steam issuing from surface waters. But this theory needs no refutation. There are, however, some serious objections to the tectonic theory of earthquakes, plausible as it may seem. In order to weigh them as we ought, we

must as briefly as possible construct a picture of the constitution of the earth's interior.

The average distance from the earth's surface to its center is sixty-three hundred and seventy kilometres. The temperature of the earth increases with the depth, at the rate, on a moderate estimate, of about one degree centigrade for every forty metres. Hence, at a depth of one thousand kilometres we would have a temperature of 25,000° C.; even if we call it only 15,000°, we should expect to find there only gases, and those in a simple state, for with that heat all the compound gases would be dissociated. The zone of fluidity for all rocks lies at a depth of about one hundred kilometres, where the temperature is 2,500° C. While the crust of the earth is between 2.5 and three times as heavy as distilled water at 4° C., its specific gravity rises toward the center of the earth to more than eleven, or about fourfold. Iron has a specific gravity of 7.8, or about threefold that of the crust of the earth; but the specific gravity of the earth at the greatest depth is considerably higher than this. Hence must arise an enormous pressure, steadily increasing toward the center, where, according to the English geophysicist, the Rev. Osmond Fisher, it reaches about three million atmospheres to the English square inch. It results from these conditions that with the enormous pressure and heat, and specific gravity, the interior of the earth consists of dissociated gases compressed to great rigidity, which exert an immense counter-pressure—for their tendency is always to expand. They pass out continuously into a zone of fluid matter, and this again is held by the pressure of the interior gases in a like compact condition. Thus a very high pressure still prevails in the lower parts of the solid crust of the earth, which is so high that even the most solid rocks there are in a latent plastic condition—that is, they behave toward different forces like plastic clay, and like it can be deformed without breaking. Rents, slides, caves, and clefts are out of the question there; things of that kind can exist only in the upper strata.

This fact constitutes a very strong objection to the tectonic theory of earthquakes, and thus the very depths of the earth speak against it. We have already mentioned that K. von Seebach estimated the depth of the earthquake focus from the movements of the waves, and found it not very great. But his estimates, as Prof. August Schmidt has shown, rest upon physically incorrect premises; according to Schmidt's more correct calculation, the center of the Charleston earthquake of 1886 lay at a depth of one hundred and twenty kilometres, where there can be no question of tectonic movements, because general fluidity is reached at one hundred kilometres. Further, the earthquake at

Lisbon, if the tectonic theory is valid, might, taking the character of the region into consideration, have been occasioned by a slide. But how large must the plunging mass, how deep the plunge or slide have been to produce such shocks as destroyed Lisbon and shook Europe to beyond Bohemia! Where can we find room in the closely compressed interior of the earth for such irruptions? Even if such a sudden sinking had left no trace in the interior, it should have left its marks on the surface. Mr. John Milne counts up not less than 8,331 considerable earthquake shocks in Japan between 1885 and 1892; Julius Schmidt, former director of the observatory in Athens, enumerated three hundred severe and dangerous and fifty thousand light shocks for Phocis alone between 1870 and 1873, of which not a trace of land changes or depressions can be perceived, aside from superficial avalanches (on Parnassus, for example) and subsidence of meadows and other spongy soil, like the famous depression of the Molo at Lisbon.

All this speaks so emphatically against the tectonic origin of earthquakes that it can not be considered as a general cause. Even the mighty disturbances and shocks of the times when such ranges as the Alps and Himalayas were lifted up can prove nothing for the present time; for the conditions, the mechanical work and acting forces, of the earth were quite different, and the latter much greater and more acute than in our time, as the number and magnitude of the volcanoes of those ages show, before which ours are almost as nothing. We have no adequate comprehension of the way that mechanical work was done. A depression like that of the plain of the Rhine could certainly not have taken place without severe earthquakes; but we do not know how they may have come to pass, for we have nothing analogous to them. The upper strata of the earth's crust are broken up, fissured, and cavernous; hence purely local minor earthquakes may undoubtedly be produced by cavings-in, landslides, and settlings of small extent. But this explanation, in view of the nature of the crust, is not possible for strong earthquakes, even in the upper layers, which send their waves far over the land; their origin must be, almost of necessity, in the greater deeps beneath the crust, far down where the immense gas globe of the interior is constantly forcing its way into the fluid band, and this into the solid stone; in those zones of changing conditions a mighty movement must be incessantly prevailing. The pressure upon the gases of the interior diminishes here, and the excessive temperature as well. This can not take place without changes. Temperature and pressure now fall, now rise again, but continue very high through it all. The dissociated gases unite and separate again, and most violent explosions are infallibly produced thereby. Water exists in the interior in immense masses, and

that not solely in consequence of percolation from the surface. Vapor at very high pressure separates into its elements—hydrogen and oxygen—the reunion of which ensues with violent explosions, similar to our gas explosions, which must be very numerous in the interior of the earth, and accompanied with great development of force. The principal effect of such explosions is, of course, against the cooler and more weakly resisting sides, and therefore not toward the interior but toward the crust and the weakest parts of it, toward the rupture lines of the zones of disturbance, the synclinals. Such attacks, striking the earth's crust from within, occasion most earthquakes, especially violent, destructive, deep-seated outbursts like those of Lisbon and Charleston. The relation of the seismic and the volcanic phenomena is clearly to be seen.

One series of seismic phenomena remains to be explained—the lighter undulations, the tremors, and the remarkable irregularity of the movements of the ground. The indications of the vertical pendulum apparatus which represent these movements form an inextricable tangle of lines running over and crossing one another. The late Japanese professor of seismology, Sekiya, prepared an enlarged model of the tracings of the seismic movements of a point of the earth's surface, which has been much copied. It represents an extremely confusing vibration of the lines.

Now we have to confront a very important fact which adds much to the difficulty of seismic research. We never feel and observe the earthquake shocks themselves, never directly in their simplicity or multiplicity, but only the wave movements that are sent out from them in the elastic crust of the earth. These, however multifold their origin, proceed in an immense spherical wave which moves in more or less numerous repetitions through the earth's interior. It is this shaking of the earth by the spherical waves that our instruments represent as earthquakes. We can not include as the earth's crust the surface of the earth on which we live, and which consists of loose materials disintegrated by weathering, breaking, and numerous causes, but the solid crust, often lying at a considerable distance beneath us, which bears these materials, and from which the spherical waves emerge. As the waves of the sea, beating upon the coast, are turned, split up, divided, thrown up, etc., in their surging, so surge, too, the seismic waves upon the disintegrated surface of shingle, pebbles, broken rocks, sand, and earth, in clefts and gorges. We thus never observe the original spherical waves, but only their fragmentary derivative forms, their resolution into numerous single waves which come to us diverted into the most various directions. It is thus most plainly shown that Mallet's effort to determine the

center and origin of the earthquake from the direction of the shock was futile. We can only draw scientific conclusions respecting the time of beginning, the duration, and force of the movement. It is thus evident that many of the tremors (not all, by any means) originate in this division; that a fixed point of the earth's surface must describe a very complicated path in so intricate a wave movement; that the division is less marked on firm ground than on loose; that the former, in consequence of the more evenly protracted movement, is less dangerous than the latter; and that multiplied waves interfere, overlay, weaken, or strengthen one another just as water waves do. Thus are explained the earthquake bridges or spots which always remain unmoved through repeated earthquakes, either because they are firmer, or because the progress of the waves is arrested at them by interference.

The sounds, too, which so frequently accompany earthquakes are likewise simply results of this division of the waves and their escape into the air, for we perceive wave motions in the air as sound. The admirable delicacy of our sense of hearing is here manifested, for seismic movements are not rarely perceptible, or heard, as air waves, which we can not perceive as movements of the ground. Earthquake thunder is caused, like storm thunder, by shocks to the air, of which we hear the nearest and latest first, and the farthest and earliest last. The different tone shades of the earthquake sound depend upon their various sources, as from small, sharp fragments, clinking, rattling, and humming; from sand and earth, dull rumbling; from trees, whistling, etc. The echo in ravines not rarely operates to add strength to them. Earthquake sounds that seem to come out of the air from above are caused by earthquake waves reaching us by way of trees, houses, etc.; the different directions and degrees of force which they seem to indicate in different houses or in different rooms of the same house are explainable by the different elasticity conditions of the houses and rooms. But not the most insignificant conclusion can be drawn from these sounds concerning the nature and causes of earthquakes. It is important to emphasize this fact, for errors have often originated in conclusions drawn from such things.—*Translated for the Popular Science Monthly from the Deutsche Rundschau.*

Examples of a race of curiously protectively colored mice which inhabit the sandy island, the North Bull, in the Bay of Dublin, were exhibited by Dr. H. Lyster Jameson in the Zoölogical Section of the British Association. A

considerable percentage of them were distinctly lighter hued than the ancestral type of house mouse, though every possible gradation occurred between the typical house mouse and the palest examples. The speaker regarded the marked predominance of sand-colored specimens as due to the action of natural selection. The hawks and owls which frequent the island, and are the only enemies the mice have to compete against, most easily capture the darkest examples, or those that contrast most strongly with the color of the sand. Thus a protectively colored race is becoming established. The island came into existence only about a hundred years ago. Consequently it is possible to fix a time limit within which the sandy-colored race has been evolved. Its evolution also, as Professor Poulton observed in his comment on Dr. Jameson's paper, gives additional evidence to that afforded by the shore crabs described by Professor Weldon in his presidential address to the section, that the transmutation of species is not necessarily so slow as to be indiscernible.

A SHORT HISTORY OF SCIENTIFIC INSTRUCTION[33]

BY J. NORMAN LOCKYER, K. C. B., F. R. S.

The two addresses by my colleagues, Professors Judd and Roberts-Austen, have drawn attention to the general history of our college and the details of one part of our organization. I propose to deal with another part, the consideration of which is of very great importance at the present time, for we are in one of those educational movements which spring up from time to time and mold the progress of civilization. The question of a teaching university in the largest city in the world, secondary education, and so-called technical education are now occupying men's minds.

At the beginning it is imperative that I should call your attention to the fact that the stern necessities of the human race have been the origin of all branches of science and learning; that all so-called educational movements have been based upon the actual requirements of the time. There has never been an educational movement for learning's sake; but of course there have always been studies and students apart from any of those general movements to which I am calling attention; still we have to come down to the times of Louis Quatorze before the study of the useless, the *même inutile*, was recognized as a matter of national concern.

It is perhaps the more necessary to insist upon stern necessity as being the origin of learning, because it is so difficult for us now to put ourselves in the place of those early representatives of our race that had to face the problems of life among conditionings of which they were profoundly ignorant: when night meant death; when there was no certainty that the sun would rise on the morrow; when the growth of a plant from seed was unrecognized; when a yearly return of seasons might as well be a miracle as a proof of a settled order of phenomena; when, finally, neither cause nor effect had been traced in the operations of Nature.

It is doubtless in consequence of this difficulty that some of the early races have been credited by some authors with a special love of abstract science, of science for its own sake; so that this, and not stern necessity, was the motive of their

inquiries. Thus we have been told that the Chaldeans differed from the other early races in having a predilection for astronomy, another determining factor being that the vast plains in that country provided them with a perfect horizon.

The first historic glimpses of the study of astronomy we find among the peoples occupying the Nile Valley and Chaldea, say 6000 B. C.

But this study had to do with the fixing of the length of the year, and the determination of those times in it in which the various agricultural operations had to be performed. These were related strictly to the rise of the Nile in one country and of the Euphrates in the other. All human activity was, in fact, tied up with the movements of the sun, moon, and stars. These, then, became the gods of those early peoples, and the astronomers, the seers, were the first priests; revered by the people because as interpreters of the celestial powers they were the custodians of the knowledge which was the most necessary for the purposes of life.

Eudemus of Rhodes, one of the principal pupils of Aristotle, in his History of Geometry, attributes the origin of geometry to the Egyptians, "who were obliged to invent it in order to restore the landmarks which had been destroyed by the inundation of the Nile," and observes "that it is by no means strange that the invention of the sciences should have originated in practical needs."[34] The new geometry was brought from Egypt to Greece by Thales three hundred years before Aristotle was born.

When to astronomy and geometry we add the elements of medicine and surgery, which it is known were familiar to the ancient Egyptians, it will be conceded that we are, in those early times, face to face with the cultivation of the most useful branches of science.

Now, although the evidence is increasing day by day that Greek science was Egyptian in its origin, there is no doubt that its cultivation in Greece was more extended, and that it was largely developed there. One of the most useful and prolific writers on philosophy and science who has ever lived, Aristotle, was born in the fourth century B. C. From him, it may be said, dates a general conception of science based on *observation* as differing from experiment. If you wish to get an idea of the science of those times, read his writings on Physics and on the Classification of Animals. All sought in Aristotle the basis of knowledge, but they only read his philosophy; Dante calls him the "master of those who know."[35]

Why was Aristotle so careful to treat science as well as philosophy, with which his master, Plato, had dealt almost exclusively?

The answer to this question is of great interest to our present subject. The late Lord Playfair[36] in a pregnant passage suggests the reason, and the later history of Europe shows, I think, that he is right.

"We find that just as early nations became rich and prosperous, so did philosophy arise among them, and it declined with the decadence of material prosperity. In those splendid days of Greece when Plato, Aristotle, and Zeno were the representatives of great schools of thought, which still exercise their influence on mankind, *Greece was a great manufacturing and mercantile community*; Corinth was the seat of the manufacture of hardware; Athens that of jewelry, shipbuilding, and pottery. The rich men of Greece and all its free citizens were actively engaged in trade and commerce. The learned class were the sons of those citizens, and were in possession of their accumulated experience derived through industry and foreign relations. Thales was an oil merchant; Aristotle inherited wealth from his father, who was a physician, but, spending it, is believed to have supported himself as a druggist till Philip appointed him tutor to Alexander. Plato's wealth was largely derived from commerce, and his master, Socrates, is said to have been a sculptor. Zeno, too, was a traveling merchant. Archimedes is perhaps an exception, for he is said to have been closely related to a prince; but if so, he is the only princely discoverer of science on record."

In ancient Greece we see the flood of the first great intellectual tide. Alas! it never touched the shores of western Europe, but it undoubtedly reached to Rome, and there must have been very much more observational science taught in the Roman studia than we generally imagine, otherwise how account for Pliny, the vast public works, their civilizing influence carried over sea and land from beyond Bab-el-Mandeb to Scotland? In some directions their applications of science are as yet unsurpassed.

With the fall of the Roman Empire both science and philosophy disappeared for a while. The first wave had come and gone; its last feebler ripples seem to have been represented at this time by the gradual change of the Roman secular studia wherever they existed into clerical schools, the more important of which were in time attached to the chief cathedrals and monasteries; and it is not difficult to understand why the secular (or scientific) instruction was gradually replaced by one more fitted for the training of priests.

It is not to be wondered at that the ceaseless strife in the center of Europe had driven what little learning there was to the western and southern extremities, where the turmoil was less—I refer to Britain and South Italy—while the exiled Nestorians carried Hellenic science and philosophy out of Europe altogether to Mesopotamia and Arabia.

The next wave—it was but a small one—had its origin in our own country. In the eighth century England was at its greatest height, relatively, in educational matters, chiefly owing to the labors of two men. Beda, generally called the Venerable Bede, the most eminent writer of his age, was born near Monkwearmouth in 673, and passed his life in the monastery there. He not only wrote the history of our island and nation, but treatises on the nature of things, astronomy, chronology, arithmetic, medicine, philosophy, grammar, rhetoric, poetry, music, basing his work on that of Pliny. He died in 735, in which year his great follower was born in Yorkshire. I refer to Alcuin. He was educated at the Cathedral School at York under Archbishop Egbert, and, having imbibed everything he could learn from the writings of Bede and others, was soon recognized as one of the greatest scholars of the time. On returning from Rome, whither he had been sent by Eaubald to receive the pallium, he met Karl the Great, King of the Franks and Lombards, who eventually induced him to take up his residence at his court, to become his instructor in the sciences. Karl (or Charlemagne) then was the greatest figure in the world, and although as King of the Franks and Lombards, and subsequently Emperor of the Holy Roman Empire, his court was generally at Aachen, he was constantly traveling throughout his dominions. He was induced, in consequence of Alcuin's influence, not only to have a school always about him on his journeys, but to establish, or foster, such schools wherever he went. Hence it has been affirmed that "France is indebted to Alcuin for all the polite learning it boasted of in that and the following ages." The universities of Paris, Tours, Fulden, Soissons, and others were not actually founded in his day, but the monastic and cathedral schools out of which they eventually sprang were strengthened, and indeed a considerable scheme of education for priests was established—that is, an education free from all sciences, and in which philosophy alone was considered.

Karl the Great died in 814, and after his death the eastward traveling wave, thus started by Bede and Alcuin, slightly but very gradually increased in height. Two centuries later, however, the conditions were changed. We find ourselves in presence of interference phenomena, for then there was a meeting with another wave traveling westward, and this meeting was the origin of the European

universities. The wave now manifested traveling westerly, spread outward from Arab centers first and finally from Constantinople, when its vast stores of Greek lore were opened by the conquest of the city.

The first wavelet justified Eudemus's generalization that "the invention of the sciences originated in practical needs," and that knowledge for its own sake was not the determining factor. The year had been determined, stone circles erected almost everywhere, and fires signaled from them, giving notice of the longest and shortest days, so that agriculture was provided for, even away from churches and the festivals of the Church. The original user of geometry was not required away from the valleys of the Nile, Tigris, and Euphrates, and therefore it is now medicine and surgery that come to the front for the alleviation of human ills. In the eleventh century we find Salerno, soon to be famed throughout Europe as the great medical school, forming itself into the first university. And medicine did not exhaust all the science taught, for Adelard listened there to a lecture on "the nature of things," the cause of magnetic attraction being one of the "things" in question.

This teaching at Salerno preceded by many years the study of the law at Bologna and of theology at Paris.

The full flood came from the disturbance of the Arab wave center by the crusades, about the beginning of the twelfth century. After the Pope had declared the "Holy War," William of Malmesbury tells us "the most distant islands and savage countries were inspired with this ardent passion. The Welshman left his hunting, the Scotchman his fellowship with vermin, the Dane his drinking party, the Norwegian his raw fish." Report has it that in 1096 no less than six millions were in motion along many roads to Palestine. This, no doubt, is an exaggeration, but it reflects the excitement of the time, and prepares us for what happened when the crusaders returned. As Green puts it:[37] "The western nations, including our own, 'were quickened with a new life and throbbing with a new energy.' ... A new fervor of study sprang up in the West from its contact with the more cultured East. Travelers like Adelard, of Bath, brought back the first rudiments of physical and mathematical science from the schools of Cordova or Bagdad.... The long mental inactivity of feudal Europe broke up like ice before a summer's sun. Wandering teachers, such as Lanfranc or Anselm, crossed sea and land to spread the new power of knowledge. The same spirit of restlessness, of inquiry, of impatience with the older traditions of mankind, either local or intellectual, that drove half Christendom to the tomb of its Lord, crowded the roads with thousands of young scholars hurrying to the chosen seats where

teachers were gathered together."

Studium generale was the term first applied to a large educational center where there was a guild of masters, and whither students flocked from all parts. At the beginning of the thirteenth century the three principal studia were Paris, Bologna, and Salerno, where theology and arts, law and medicine, and medicine almost by itself, were taught respectively; these eventually developed into the first universities.[38]

English scholars gathered in thousands at Paris round the chairs of William of Champeaux or Abélard, where they took their place as one of the "nations" of which the great middle-age university of Paris was composed.

We have only to do with the arts faculty of this university. We find that the subject-matter of the liberal education of the middle age there dealt with varied very little from that taught in the schools of ancient Rome.

The so-called "artiens," students of the arts faculty, which was the glory of the university and the one most numerously attended, studied the seven arts of the trivium and quadrivium—that is, grammar, rhetoric, dialectic and arithmetic, geometry, music, astronomy.[39]

This at first looks well for scientific study, but the mathematics taught had much to do with magic; arithmetic dealt with epacts, golden numbers, and the like. There was no algebra, and no mechanics. Astronomy dealt with the system of the seven heavens.

Science, indeed, was the last thing to be considered in the theological and legal studia, and it would appear that it was kept alive more in the medical schools than in the arts faculties. Aristotle's writings on physics, biology, and astronomy were not known till about 1230, and then in the shape of Arab-Latin translations. Still, it must not be forgotten that Dante learned some of his astronomy, at all events, at Paris.

Oxford was an offshoot of Paris, and therefore a theological studium, in all probability founded about 1167,[40] and Cambridge came later.

Not till the Reformation (sixteenth century) do we see any sign of a new educational wave, and then we find the two which have had the greatest influence upon the history of the world—one of them depending upon the Reformation itself, the other depending upon the birth of experimental inquiry.

Before the Reformation the universities were priestly institutions, and derived their authority from the Popes.

The universities were for the few; the education of the people, except in the various crafts, was unprovided for.

The idea of a general education in secular subjects at the expense of the state or of communities is coeval with the Reformation. In Germany, even before the time of Luther, it was undreamed of, or rather, perhaps, one should say, the question was decided in the negative. In his day, however, his zeal first made itself heard in favor of education, as many are now making themselves heard in favor of a better education, and in 1524 he addressed a letter to the councils of all the towns in Germany, begging them to vote money not merely for roads, dikes, guns, and the like, but for schoolmasters, so that all children might be taught; and he states his opinion that if it be the duty of a state to compel the able-bodied to carry arms, it is *a fortiori* its duty to compel its subjects to send their children to school, and to provide schools for those who without such aid would remain uninstructed.

Here we have the germ of Germany's position at the present day, not only in scientific instruction but in everything which that instruction brings with it.

With the Reformation this idea spread to France. In 1560 we find the States-General of Orleans suggesting to Francis II a "levée d'une contribution sur les bénéfices ecclésiastiques pour raisonablement stipendier des pédagogues et gens lettrés, en toutes villes et villages, pour l'instruction de la pauvre jeunesse du plat pays, et soient tenus les pères et mères, à peine d'amende, à envoyer les dits enfants à l'école, et à ce faire soient contraints par les segnieurs et les juges ordinaires."

Two years after this suggestion, however, the religious wars broke out; the material interests of the clerical party had predominated, the new spirit was crushed under the iron heel of priestcraft, and the French, in consequence, had to wait for three centuries and a revolution before they could get comparatively free.

In the universities, or at all events alongside them, we find next the introduction not so much yet of science as we now know it, with its experimental side, as of the scientific spirit.

The history of the Collége de France, founded in 1531 by Francis I, is of extreme

interest. In the fifteenth century the studies were chiefly literary, and except in the case of a few minds they were confined merely to scholastic subtleties, taught (I have it on the authority of the Statistique de l'Enseignement Supérieur) in barbarous Latin. This was the result of the teaching of the faculties; but even then, outside the faculties, which were immutable, a small number of distinguished men still occupied themselves in a less rigid way in investigation; but still these studies were chiefly literary. Among those men may be mentioned Danès, Postel, Dole, Guillaume Budé, Lefèvre d'Étaples, and others, who edited with notes and commentaries Greek and Latin authors whom the university scarcely knew by name. Hence the renaissance of the sixteenth century, which gave birth to the Collége de France, the function of which, at the commencement, was to teach those things which were not in the ordinary curriculum of the faculties. It was called the Collége des Deux Langues, the languages being Hebrew and Greek. It then became the Collége des Trois Langues, when the king, notwithstanding the opposition of the university, created in 1534 a chair of Latin. There was another objection made by the university to the new creation: from the commencement the courses were free; and this feeling was not decreased by the fact that around the celebrated masters of the Trois Langues a crowd of students was soon congregated.

The idea in the mind of Francis I in creating this Royal College may be gathered from the following edict, dated in 1545: "François, etc., savoir faisons à tous présents et à venir que Nous, considérant que le sçavoir des langues, qui est un des dons du Saint-Esprit, fait ouverture et donne le moyen de plus entière connaissance et plus parfaite intelligence de toutes bonnes, honnêtes, saintes et salutaires sciences.... Avons fait faire pleinement entendre à ceux qui, y voudraient vacquer, les trois langues principales, Hébraïque, Grecque, et Latine, *et les Livres esquels les bonnes sciences* sont le mieux et le plus profondément traitées. A laquelle fin, et en suivant le décret du concile de Vienne, nous avons piéça ordonné et establi en nôtre bonne ville de Paris, un bonne nombre de personnages de sçavoir excellent, qui lisent et enseignent publiquement et ordinairement les dites langues et sciences, maintenant florissantautant ou plus qu'elles ne firent de bien longtemps ... auxquels nos lecteurs avons donné honnêtes gages et salaires, et iceux fait pourvoir de plusieurs beaux bénéfices pour les entretenir et donner occasion de mieux et plus continuellement entendre au fait de leur charge, ... etc."

The Statistique, which I am following in this account, thus sums up the founder's intention: "Le Collége Royal avait pour mission de propager les nouvelles

connaissances, les nouvelles découvertes. Il n'enseignait pas la science faite, il la faisait."

It was on account of this more than on account of anything else that it found its greatest enemy in the university. The founding of this new college, and the great excitement its success occasioned in Paris, were, there can be little doubt, among the factors which induced Gresham to found his college in London in 1574.

These two institutions played a great part in their time. Gresham College, it is true, was subsequently strangled, but not before its influence had been such as to permit the Royal Society to rise phœnixlike from its ashes; for it is on record that the first step in the forming of this society was taken after a lecture on astronomy by Sir Christopher Wren at the college. All connected with them felt in time the stupendous change of thought in the century which saw the birth of Bacon, Galileo, Gilbert, Hervey, Tycho Brahe, Descartes, and many others that might be named; and of these, it is well to remark, Gilbert,[41] Hervey, and Galileo were educated in medical schools abroad.

Bacon was not only the first to lay down *regulæ philosophandi*, but he insisted upon the far-reaching results of research, not forgetting to point out that "*lucifera experimenta, non fructifera quærenda*,"[42] as a caution to the investigator, though he had no doubt as to the revolution to be brought about by the ultimate application of the results of physical inquiry.

As early as 1560 the Academia Secretorum Naturæ was founded at Naples, followed by the Lincei in 1609, the Royal Society in 1645, the Cimento in 1657, and the Paris Academy in 1666.

From that time the world may be said to have belonged to science, now no longer based merely on observation but on experiment. But, alas! how slowly has it percolated into our universities.

The first organized endeavor to teach science in schools was naturally made in Germany (Prussia), where, in 1747 (nearly a century and a half ago), Realschulen were first started; they were taken over by the Government in 1832, and completely reorganized in 1859, this step being demanded by the growth of industry and the spread of the modern spirit. Eleven hours a week were given to natural science in these schools forty years ago.

TEACHING THE TEACHERS.—Until the year 1762 the Jesuits had the education of France almost entirely in their hands, and when, therefore, their expulsion was

decreed in that year, it was only a necessary step to create an institution to teach the future teachers of France. Here, then, we had the École Normale in theory; but it was a long time before this theory was carried into practice, and very probably it would never have been had not Rolland d'Erceville made it his duty for more than twenty years, by numerous publications, among which is especially to be mentioned his Plan d'Education, printed in 1783, to point out not merely the utility but the absolute necessity for some institution of the kind. As generally happens in such cases, this exertion was not lost, for in 1794 it was decreed that an École Normale should be opened at Paris, "ou seront appelés de toutes les parties de la République, des citoyens déjà instruits dans les sciences utiles, pour apprendre, sous les professeurs les plus habiles dans tous les genres, l'art d'enseigner."

To follow these courses in the art of teaching, one potential schoolmaster was to be sent to Paris by every district containing twenty thousand inhabitants. Fourteen or fifteen hundred young men therefore arrived in Paris, and in 1795 the courses of the school were opened first of all in the amphitheater of the Museum of Natural History. The professors were chosen from among the most celebrated men of France, the sciences being represented by Lagrange, Laplace, Haüry, Monge, Daubenton, and Berthollet.

While there was this enormous progress abroad, represented especially by the teaching of science in Germany and the teaching of the teachers in France, things slumbered and slept in Britain. We had our coal and our iron, our material capital, and no one troubled about our mental capital, least of all the universities, which had become, according to Matthew Arnold (who was not likely to overstate matters), mere *hauts lycées*, and "had lost the very idea of a real university";[43] and since our political leaders generally came from the universities, little more was to be expected from them.

Many who have attempted to deal with the history of education have failed to give sufficient prominence to the tremendous difference there must necessarily have been in scientific requirements before and after the introduction of steam power.

It is to the discredit of our country that we, who gave the perfected steam engine, the iron ship, and the locomotive to the world, should have been the last to feel the next wave of intellectual progress.

All we did at the beginning of the century was to found mechanics' institutions.

They knew better in Prussia, "a bleeding and lacerated mass";[44] after Jena (1806), King Frederick William III and his councilors, disciples of Kant, founded the University of Berlin, "to supply the loss of territory by intellectual effort." Among the universal poverty money was found for the Universities of Königsberg and Breslau, and Bonn was founded in 1818. As a result of this policy, carried on persistently and continuously by successive ministers, aided by wise councilors, many of them the products of this policy, such a state of things was brought about that not many years ago M. Ferdinand Lot, one of the most distinguished educationists of France, accorded to Germany "a supremacy in science comparable to the supremacy of England at sea."

But this position has not been obtained merely by founding new universities. To Germany we owe the perfecting of the methods of teaching science.

I have shown that it was in Germany that we find the first organized science teaching in schools. About the year 1825 that country made another tremendous stride. Liebig demonstrated that science teaching, to be of value, whether in the school or the university, must consist to a greater or less extent in practical work, and the more the better; that book work was next to useless.

Liebig, when appointed to Giessen, smarting still under the difficulties he had had in learning chemistry without proper appliances, induced the Darmstadt Government to build a chemical laboratory in which the students could receive a thorough practical training.

It will have been gathered from this reference to Liebig's system of teaching chemistry that still another branch of applied science had been created, which has since had a stupendous effect upon industry; and while Liebig was working at Giessen, another important industry was being created in England. I refer to the electric telegraph and all its developments, foreshadowed by Galileo in his reference to the "sympathy of magnetic needles."

Not only then in chemistry, but in all branches of science which can be applied to the wants of man, the teaching must be practical—that is, the student must experiment and observe for himself, and he must himself seek new truths.

It was at last recognized that a student could no more learn science effectively by seeing some one else perform an experiment than he could learn to draw effectively by seeing some one else make a sketch. Hence in the German universities the doctor's degree is based upon a research.

Liebig's was the *fons et origo* of all our laboratories—mechanical, metallurgical, chemical, physical, geological, astronomical, and biological.—*Nature*.

[*To be continued*.]

SHOULD CHILDREN UNDER TEN LEARN TO READ AND WRITE?

By Prof. G. T. W. PATRICK.

There are certain propositions about education so evidently true that probably no parent or teacher would question them. For instance, the best school is one in which the course of study is progressively adapted to the mental development of the children. Again, certain subjects are adapted to children of certain ages or stages of development, and others are not. One would not recommend the study of logic or of the calculus to the average child of ten, nor would the teaching of English be wisely deferred until the age of fifteen. Finally, if the courses of study in our present school system shall be found to be arranged without regard to the order of mental development, they will sooner or later be modified in accordance with it.

Now the educational system in practice in the two or three hundred thousand public schools in the United States is a somewhat definite one, with a somewhat fixed order of studies through the different years or grades. In a majority of the States children are admitted to the schools at the age of six; in more than one third of the States children of five are admitted. In a general way we may say that during the first four years of school life the principal subjects occupying the time of the children are reading, writing, and arithmetic. To be more exact, we may cite, for instance, the city schools of Chicago.[45] Exclusive of recesses and opening exercises, there are in these schools thirteen hundred and fifty minutes of school work per week. Of this time, in the first and second grades, six hundred and seventy-five minutes are devoted to reading, seventy-five minutes to writing, and two hundred and twenty-five minutes to mathematics. Seventy-two per cent of the total time is therefore consumed by these subjects. In the third grade the proportion is the same; in the fourth grade it is somewhat more than fifty per cent. I have mentioned the Chicago schools because this is one of those school systems where a liberal introduction of other subjects, such as Nature study, physical culture, singing, and oral English, has somewhat lessened the time given to reading, writing, and arithmetic. Other cities, with few exceptions, will be found to give more rather than less time to these subjects. In the country schools, and indeed in a vast number of town and city schools,

practically all the time during these early years is given to reading, writing, and arithmetic.

We must conclude, therefore, if our educational system is a rational one, that reading, writing, and arithmetic are the subjects peculiarly adapted to the mind of the child between the ages of five and ten. It is worth while to inquire from the standpoint of child psychology whether this be true. It should be observed, in the first place, that the manner in which our educational system has grown up is no guarantee that it rests upon a psychological basis. Our schools are exceedingly conservative. Any innovations or radical changes are resisted by the parents of the children even more strenuously than by school boards, superintendents, and teachers. Notwithstanding numerous and important minor improvements, the school system as a whole remains unchanged. Our children of seven and eight years are learning to read and write because our grandfathers were so doing at that age.

We can not here discuss the origin of our present school curriculum, but, as explaining the prominence given to reading, writing, and arithmetic, it is worthy of notice that originally the elementary school existed to teach just these three subjects. The primitive schoolmaster was not superior to the parents of the child, usually not their equal, in anything except his knowledge of "letters." So the child was sent to school for a short time to learn letters. It was not at all the function of the school to *educate* the child in all that was necessary to fit him for the duties of life. Afterward, as the scope of the school was enlarged, other subjects were added, and these were put *after* the original ones, and the schoolmaster, furthermore, came rather to take the place of an educator than a mere teacher of letters. It is conceivable, therefore, that the present accepted order of studies in our elementary schools rests upon an accidental rather than upon a psychological basis. It is true that modern educators have expressly considered the subject of the order and correlation of studies, as, for instance, in the case of the Committee of Fifteen, and that, while recommending minor changes in the school curriculum, they have not usually thought of questioning the position so long held by reading, writing, and arithmetic. In the report of the committee just referred to we find this expression: "The conclusion is reached that learning to read and write should be the leading study of the pupil in his first four years of school." But, again, it was not the function of this committee to suggest sweeping changes, nor to raise the inquiry whether the system itself rests upon a psychological basis. Even if it did not rest upon such a basis, expressions like the above would not be unnatural on the part of committees appointed by

bodies representing the system as a whole.

We may not, then, conclude *a priori* that our system of primary education is a sound one. There have indeed been other wholly different systems giving excellent results in their time, as, for instance, that of the ancient Greeks, where music and gymnastics, not reading, writing, and arithmetic, were the principal subjects occupying the time of the pupils.

Much attention has recently been given to the subjects of the physiology and psychology of children. These studies have been systematic, painstaking, and exact. It seems, indeed, to many people improbable that anything very new or very remarkable should just at this time be found out about children, and there have not been wanting either prominent educators or psychologists who have given public expression to warnings against the new "child study." But this, again, is not conclusive, for students of history may recall that every advance in science has met just such opposition—for instance, bacteriology, organic evolution, chemistry, and astronomy. Furthermore, when we reflect that scientific advance in this century has ever been, and inevitably, from the simple to the complex, and, further, that the brain of the child is the most complex thing in the whole range of natural history which science will ever have to attempt, it is not difficult to understand that scientific knowledge of it with its pedagogical implications has not belonged, at any rate, to the past. It will belong to the future, having, perhaps, its beginnings in the present. An educational system which has not reckoned with an accurate knowledge of the brain of the child may by accident be a correct one, but until such reckoning is made we can not be sure.

Our increasing knowledge of the child's mind, his muscular and nervous system, and his special senses, points indubitably to the conclusion that reading and writing are subjects which do not belong to the early years of school life, but to a later period, and that other subjects now studied later are better adapted to this early stage of development. What is thus indicated of reading and writing may be affirmed also of drawing and arithmetic. The reasons leading to this conclusion can be only very briefly summarized here.

As regards reading, writing, and drawing, they involve, in the first place, a high degree of motor specialization, which is not only unnatural but dangerous for young children. Studies in motor ability have shown that the order of muscular development is from the larger and coarser to the finer and more delicate muscles. The movements of the child are the large, free movements of the body,

legs, and arms, such as he exhibits in spontaneous play. The movements requiring fine co-ordination, such as those of the fingers and the eyes, are the movements of maturer life. If we reverse this order and compel the child to hold his body, legs, and arms still, while he engages the delicate muscles of the eyes and fingers with minute written or printed symbols, we induce a nervous overtension, and incur the evils incident to all violation of natural order. The increasing frequency of nervous disorders among school children, particularly in the older countries, is probably due in part to these circumstances. If we consider the brain of the child of seven or eight years, our conclusions are strengthened that he should not be engaged in reading and writing. At this age the brain has attained almost its full weight, and is therefore large in proportion to the body. Its development is, however, very incomplete, particularly as regards its associative elements—that is, the so-called association fibers and apperception centers. Such a brain constantly produces and must expend a large amount of nervous energy, which can not be used centrally—that is, psychologically speaking—in comparison, analysis, thought, reflection. It must flow out through the motor channels, becoming muscular movement. The healthy child is therefore incessantly active in waking hours, the action being of the vigorous kind involving the larger members. Hence we can understand that, of all the ways in which a young child may receive instruction, the method through the printed book is pre-eminently the one ill fitted to him.

The evil of this method is aggravated by the fact that, before the child can receive instruction through the book, a long time—several years, in fact—is spent in the confining task of learning to read. It comes about, therefore, that the child, at the very age when he should be leading a free and expansive life, is obliged to fix his eyes upon the narrow page of a book and decipher small printed symbols, in themselves devoid of life and interest. With respect to writing and learning to write the case is worse. A considerable amount of motor specialization is involved in forming letters upon the blackboard, but when the pencil and pen are used it becomes of an extreme kind. In the whole life history of the man there are no movements requiring finer co-ordination than those of writing with pencil or pen, yet our school system requires these of the child of six or seven years, makes them, indeed, a prominent part of elementary school life. In addition to the motor specialization of reading and writing is the physical confinement in the narrow seat and desk which is necessarily connected with them. The child of six or seven has not reached the age when such confinement is natural or safe.

The injuries which I have mentioned relate to the nervous system as a whole. There are other injuries resulting from the reading habit in young children which concern the eyes directly. So much has been said and written lately about the increase of myopia and other defects of the eye among school children, that I shall merely refer to this subject here. Upon entering school, children are practically free from these defects. Upon leaving school, a strikingly large percentage are suffering from them, more, however, as yet, in European countries than in America. The causes are many, but it is scarcely doubted that the chief cause is found in bending over finely printed books and maps, and fine writing, pencil work, and drawing. If pencils, pens, paper, and books could be kept away from children until they are at least ten years of age, and their instruction come directly from objects and from the voice of the teacher, this evil could be greatly lessened.

If the above reasons for not teaching reading and writing to young children were the only ones, the objections could to a certain extent be overcome. Writing might, for instance, be practiced only on the blackboard with large free-hand movements, and letters could be taught from large forms upon charts. But we have to consider the questions whether reading and writing are in themselves branches of instruction which belong to the early years of school life, whether they may not be acquired at a great disadvantage at this period, and whether more time is not spent upon them than is necessary. It is a well-known fact that a child's powers, whether physical or mental, ripen in a certain rather definite order. There is, for instance, a certain time in the life of the infant when the motor mechanism of the legs ripens, before which the child can not be taught to walk, while after that time he can not be kept from walking. Again, at the age of seven, for instance, there is a mental readiness for some things and an unreadiness for others. The brain is then very impressionable and retentive, and a store of useful material, both motor and sensory, may be permanently acquired with great economy of effort. The imagination is active, and the child loves to listen to narration, whether historical or mythical, which plays without effort of his will upon his relatively small store of memory images. The powers of analysis, comparison, and abstraction are little developed, and the child has only a limited ability to detect mathematical or logical relations. The power of voluntary attention is slight, and can be exerted for only a short time. All this may be stated physiologically by saying that the brain activity is sensory and motor, but not central. The sensory and motor mechanism has ripened, but not the associative. The brain is hardly more than a receiving, recording, and reacting apparatus. It would be inaccurate, however, to express this psychologically by saying that perception, memory, and will are the mental powers that have ripened at the age of seven. This would be true only if by perception we mean not apperception, which involves a considerable development of associative readiness, but mere passive apprehension through the senses, and if by memory we mean not recollection, but mere retentiveness for that which interests, and if by will we mean not volition, but only spontaneous movement and readiness to form habits of action, including a large number of instinctive movement psychoses, such as imitation, play, and language in its spoken form.

Following out, then, somewhat as above, the psychology of the child, what kind of education would be particularly adapted to his stage of development? We ask not what *can* the child be taught, but what studies are for him most natural and

therefore most economical. In the first place, from the development of the senses and the perceptive power above described, we infer that the child is ready to acquire a knowledge of the world of objects around him through the senses of sight, hearing, touch, temperature, taste, and smell. His education will have to do with real things and their qualities, rather than with symbols which stand for things. If we wish a general term for this branch of instruction, we may call it natural science, or, to distinguish it from science in its more mature form as the study of laws and causes, we may call it natural history, or, more briefly, Nature study. Although the appropriateness and economy of this study for young children has been known and proclaimed for more than a century, it is still in practice the study of later years, while young children study *letters*.

In the second place, from the development of the retentive powers of the child we infer that he is qualified to gain acquaintance not only with the real world around him, but with the real world of the past. We may call this history. History is now studied later by means of text-books. It may be studied with far greater economy during earlier years by means of direct narration by parent or teacher. It is wonderful how eagerly a child will listen to historical narration, and how easily he will retain it. This method of teaching history forms a striking contrast to the perfunctory manner in which it is often studied in the upper school grades, with the text-book "lesson," "recitation," and the "final examination." Upon the minds of many young people the study of history has a deadening effect when the history epoch is passed and the mathematical epoch has arrived. It has already been proposed, at a conference of educators lately held in Chicago, to extend the study of history downward into the lower grades, a proposition fully sanctioned by psychological pedagogy. In what I have here said about history for young people I refer not to the philosophy of history, which comes much later in the life of the student, but to history as a mere record of facts and events, the kind of history which is now studied in the grammar and high schools, the kind which many educators who would make all children philosophers are now saying should not be studied at all.

In the third place, what studies correspond to the development of the will in the child from five to ten? It is the habit-forming epoch. It is the time when a large and useful store of motor memory images may be acquired, and when permanent reflex tracts may be formed in the spinal cord and lower brain centers. This is the time to teach the child to do easily and habitually a large number of useful things. If we use the term in its broadest sense, we may call this branch of instruction morals, but it will also include, besides habits of conduct, various

bodily activities, certain manual dexterities, and correct habits of speech, expression, and singing. But here some restrictions must be observed. The habit-forming period begins at birth and continues far beyond the age of ten, and the period from five to ten is not the time for the formation of all habits. The order of muscular development must be observed, and all dexterities involving finely co-ordinated movements of the fingers, or strain of the eyes, should be deferred beyond this period, or at most begun only in the latter part of it; such, for instance, as writing, drawing, modeling, sewing, knitting, playing upon musical instruments, and minute mechanical work, as well, of course, as the plaiting, pricking, stitching, weaving, and other finger work still practiced in some kindergartens and primary schools.

We have thus seen that there are certain branches of instruction for which the mind of the child from five to ten has ripened, and which may therefore be taught most economically and safely during this period. Concerning the teaching of language I shall speak presently, but thus far we have found that from the psychological standpoint there are at any rate three subjects which are strikingly adapted to this period, namely, natural science, history, and morals, using these terms with the latitude and restriction already explained. Certain branches of Nature study and one branch of what we have called morals—namely, manual training—have in recent years been introduced into our best elementary city schools, and in a few schools history is taught systematically in the lower grades by means of stories. They have not, however, crowded out reading, writing, and arithmetic so much as crowded into them. But if we consider the great mass of schools in city, town, and country throughout the land, the subjects which practically complete the elementary school curriculum—reading, writing, arithmetic, and geography—are, with the exception of the latter, found to be subjects which do not naturally belong to this period at all. Mathematics in every form is a subject conspicuously ill fitted to the child mind. It deals not with real things, but with abstractions. When referred to concrete objects, it concerns not the objects themselves, but their relations to each other. It involves comparison, analysis, abstraction. It calls for a fuller development of the association tracts and fibers of the cerebral hemispheres. The grotesque "number forms" which so many children have, and which originate in this period, are evidence of the necessity which the child feels of giving some kind of bodily shape to these abstractions which he is compelled to study. Under mathematics I do not of course include the mere mentioning or learning a number series, such as in the process called "counting," or the committing to memory of a multiplication table. Furthermore, in this and in all discussions of this kind it must be

remembered that there are exceptional children in whom the mathematical faculty, or musical faculty, or literary faculty, develops much earlier than with the average child. If possible, they should have instruction suited to their peculiarities. But it is evident that, so long as children are educated in "schools," there must be a general plan of education, and that it can not be based upon exceptional children.

What we learn from physiology and psychology about the ripening of the child's mind is confirmed by the theory of the "culture epochs." I can not discuss here the doctrine of "recapitulation," with its great truths and its minor exceptions, but it is well known that in a general way the development of the child, both physical and mental, is an epitome of the development of the race. If we compare the physical and mental activities of the modern civilized man with those of the more primitive member of the race, we may learn what forms of physical and mental activity are natural in the different periods of child life. Some of the things which are characteristic of the modern as contrasted with the primitive man are sedentary habits, manual dexterities requiring finely co-ordinated movements both of the eyes and fingers, increasing devotion to written language and books as contrasted with spoken language, the lessened dependence upon the memory, the increasing subjectivity of mental life as contrasted with the purely objective life of the savage, and the increased importance of reflection, deliberation, and reasoning, with decrease of impulsive and habitual action. These things, then, we should expect to belong to the later period of child life, and studied which involve these activities will not be economically pursued in the elementary school grades. These laws are wholly overlooked in our traditional school curriculum. In practice we are saying to the young child: "Man is a sedentary, reading, writing, thinking, reasoning being, possessing the power of voluntary attention. I am to educate you to be a man. Therefore you must learn to sit still, to read, write, think, reason, and give attention to your work." The child of six or eight years is therefore given a book or pen, and put into a closely fitting seat and left to give attention to his work. This is precisely as if the mother should say to the infant at the beginning of the period of creeping: "You are a man, not a brute. Men go upright, not on all fours. You must walk, not creep."

I wish to call especial attention to the fact that it is only late in the history of the race that language has passed to its written form. Man is indeed now a reading and writing animal, but only recently has he become so. It is only since the invention of printing and the wide dissemination of books, magazines, and

newspapers that reading has become a real determining factor in the life of the people. Even now the human organism is engaged in adapting itself to the new strain brought upon the eyes and fingers in reading and writing. We can understand, therefore, that it will demand a considerable maturity in the child before he is ready for that which has developed so late in the history of the race. The language of the child, like that of the primitive man, is the language of the ear and tongue. The child is a talking and hearing animal. He is ear-minded. There has been in the history of civilization a steady development toward the preponderating use of the higher senses, culminating with the eye. The average adult civilized man is now strongly eye-minded, but it is necessary to go back only to the time of the ancient Greeks to find a decided relative ear-mindedness. Few laboratory researches have been made upon the relative rapidity of development of the special senses in children, but such as have been made tend to confirm the indications of the "culture epochs" theory, and to show that the auditory centers develop earlier than the visual.

More and more attention is given in our elementary schools to the subject of language—more, as some think, than the relative importance of the subject warrants; but without discussing this question, it is indubitably shown by child psychology that it is the spoken language which belongs to the elementary school. The ear is the natural medium of instruction for young children, and all the second-hand knowledge which it is necessary that the child should receive should come to him in this way. It should come from the living words of the living teacher or parent, not through the cold medium of the printed book. In the elementary school, then, the child may be instructed in language as it relates to the ear and the tongue, and this is the real language. He may be taught to speak accurately and elegantly, and he may be taught to listen and remember. He may study in this way the best literature of his mother tongue, and get a living sympathetic knowledge of it, such as can never come through the indirect medium of the book. Indeed, this language study need not be limited to the mother tongue. There is no age when a child may with so great economy of effort gain a lasting knowledge of a foreign language as when he is from seven to eleven years old.

When the spoken language has been mastered in this way, and when the child has arrived at the reading and writing age, language in its written form may be acquired in a very short time, and that which now fills so many weary years of school life will sink into the position of comparative insignificance in which it rightfully belongs. Reading and writing have usurped altogether too much time.

In the schools of to-day there is a worship of the reading book, spelling book, copy book, and dictionary not rightfully due them. By dropping the study of letters from the lower grades much needed time may be found for other timely and important subjects, such as Nature study, morals, history, oral language, singing, physical training, and play.

One of the greatest goods which would follow the banishing of the book from the primary and elementary schools would be the cultivation of better mental habits. Children suffer lasting injury by being left with a book in their seats and directed to "study" at an age when the power of voluntary attention has not developed. They then acquire habits of listlessness and mind-wandering afterward difficult to overcome. They read over many times that which does not hold their attention and is not remembered. Lax habits of study are thus acquired, with the serious incidental result of weakening the retentive power which depends so much upon interest and concentration. With the substitution of the oral for the book method, reliance upon the memory during the memory period will permanently strengthen the child's power of retention.

The period between the ages of five and ten years is an important one in the child's life. It is the time when the "let-alone" plan of education is of most value, for the reason that nearly all our educational devices beyond the kindergarten are more or less attempts to make men and women out of children. If the child at this age must be put into the harness of an educational system, his course of study will not be impoverished by the omission of reading and writing. To teach him to speak and to listen, to observe and to remember, to know something of the world around him, and instinctively to do the right thing, will furnish more than enough material for the most ambitious elementary school curriculum.

SOILS AND FERTILIZERS.[46]

BY CHARLES MINOR BLACKFORD, JR., M. D.

The word "soil" is used in several arts and sciences to denote the material from which something derives nourishment. The meat broths and jellies on which bacteria are grown are soils for them, as the earth of a field is a soil for the ordinary farm crops; but in general we mean by soils the various mixtures of mineral and organic substances that make up the surface of the earth.

The object of this paper is to show as briefly as possible the way it was formed, of what it is composed, the manner in which it nourishes plants, and the rules that should guide us in replenishing its nutritious matter when exhausted. So broad a field can be but lightly touched, and the effort will be to give only hints from which rules for specific cases may be deduced.

When a sample of ordinary fertile soil is analyzed, it is found to consist of a number of minerals, of carbon, nitrogen, and phosphorus in various combinations, water, and certain other ingredients dependent on the locality. Among the minerals the most important are potassium, sodium, lime, iron, and silicon, and the history of these is of the greatest interest.

Scientific students are generally agreed that the surface of the earth is but a shell inclosing a liquid, or at all events a highly heated interior. Originally the whole mass was fluid, but the surface has cooled more rapidly than the interior, and so a firm crust has been formed. As the central mass cooled, it contracted, and the crust became wrinkled and folded, as does the skin of an apple as its pulp dries, and, by this folding, great ridges were thrown up in some places and vast depressions formed in others. When the crust became cool enough for water to remain on it, most of the depressions were filled by it, and the "dry land appeared," not only on the crests of the ridges, but on the elevated plateaus about them, and thus oceans and continents were formed.

Had one of us seen the earth at that time he would have been loath to select it as a residence. Rugged, rocky ranges of precipitous mountains surrounded by stretches of naked rock made the landscape. Dense clouds from the tepid oceans dashed against the icy peaks, and torrents of water rushed back to the sea. Where

the slopes permitted, the glaciers spread over wide areas, for no vegetation checked the rapid radiation of heat, and night brought bitter cold. The crust waved and fluctuated over the liquid interior as does thin ice under a daring skater, and as it fell the sea rushed over the land, only to flow elsewhere as the depressed area rose again. The freezing and thawing and the effects of wind and water in time produced a change. The rocks were riven and broken to powder, their nearly vertical slopes became less steep, and instead of bare rock the earth showed dreary morasses and stretches of sand.

Over these marshes vegetation began to thrive. In the sea there lived then, as now, a teeming population, animal, vegetable, and living beings that can with difficulty be assigned to either of these classes. Each of them, however, contained carbon, and many had built lime, phosphorus, nitrogen, and other valuable substances into their bodies. Where food was abundant these grew in vast numbers, and though many are infinitely small singly, their aggregate mass is enormous. Among the tiny organisms is one called the *Globigerina*, a being so small as to require a microscope to study it, but in the past, as now, growing in great numbers in the sea. The animal is soft and jellylike, but it forms an outside skeleton of shell of carbonate of calcium or chalk, a structure that protects it living, but entombs it dead. When death comes, the little *Globigerina* sinks to the bottom, and its tiny shell helps to cover the sea floor.

In the days of long ago these lived as now, and when some convulsion of Nature lifted the bottom of prehistoric seas, the *Globigerina* ooze was lifted as well, and thus the "limestone" formed. In our land a bed of this kind extends from Alabama to Newfoundland; thence, as the "telegraphic plateau," it passes under the Atlantic, rising into the chalk downs and cliffs of England; then, again dipping under the sea, it passes through Europe, and finally furnishes the marble quarries of Greece. Heat, water, and chemical action give a ceaseless variety to the forms of the limestone, but wherever found it shows the former seat of an ocean.

As soon as the "ooze" was lifted from below the sea it began to change. Some has been exposed to heat and has crystallized into marble, but for our purposes the most interesting changes have been wrought by water. Chalk, limestone, and marble—for these are chemically the same—are almost insoluble in pure water. But water is rarely pure; it dissolves many things, and among them the carbonic-oxide gas that every fire, every animal, every decaying scrap of wood is pouring into the atmosphere. The rain, charged with this gas, dissolves the limestone, but when the gas escapes the lime falls, as you know happens when "hard" water is

boiled, for the heat drives off the gas. By this solution, however, the lime is scattered widely through the soil, and is rarely lacking in untilled earth.

Besides lime, phosphorus is necessary in a good soil. This is widely spread in Nature, but its great reservoir is the ocean, that boundless mine of wealth. Many marine animals have the power of building it into their tissues, and the shells of oysters and other mollusks, the bones of nearly all animals, terrestrial and marine, and parts of other organisms, are composed of phosphates to a greater or less degree. In the ceaseless changes of level the primal oyster beds and coral reefs are raised to the surface or far above it, and the slow action of time begins to tear down the deposits and spread them wide-cast. Since that far-off time "in the beginning" no new matter has been put on earth save the small amounts of the meteorites, and the economy of Nature can allow not one atom to lie in idleness, but calls on each one to play its part ceaselessly, "without haste and without rest." A certain amount of a substance is disseminated through the earth; by rains it is washed into the streams, and thence to the sea. Here plants or animals eagerly await it, and by means of them it is again restored to the land, to begin again its endless round.

The metals most necessary for plant life are potassium, sodium, and iron; indeed, the very name of the first shows its importance. If the ashes which contain all the mineral constituents of plants be put in a vessel and water poured on them, a solution of lye will percolate through the mass. The word lye is an abbreviation for alkali, and when chemistry became sufficiently advanced, a metal was discovered in this lye to which the name potassium—i. e., potash-metal—was given. If seaweeds be burned and leeched in the same way we can obtain from the lye another metal, sodium, that is much like potassium, and that is one of the most widely spread substances on earth as its chloride, or common salt.

Potassium and sodium enter into the composition of many rocks, and as these become eroded by weather they are scattered through the soil, whence their salts are extracted by rootlets and enter into the formation of vegetable tissue.

Behind these stands iron. The green coloring matter of plants is a very complex substance known as chlorophyll, the duty of which is to take carbonic oxide from the air, utilize the carbon, and restore the oxygen. Iron enters into the composition of chlorophyll, and to it is due the brown color of dead leaves. This metal is well-nigh universal, all the reds and browns in soils and rocks being made by it, and so it is rarely lacking anywhere.

So much for the metals in soils; but, important as they are, plants can not live on them alone. Among the nonmetallic bodies phosphorus stands high among essentials, and for it we are indebted to the sea and the interior of the earth. Many living creatures extract phosphorus from the sea water—combine it chiefly with lime, and use the phosphate for making skeletons or shells, as the case may be. After the death of the possessors the bones or shells sink to the bottom, as do the *Globigerina*, and in time are either lifted up, as were the limestones, and form "phosphate beds" like those of Georgia and Florida, or are dredged up and ground into powder with bones of land animals.

Much of the matter forced up from the interior of the earth contains phosphorus; indeed, it is the bane of Southern iron ores; but though iron masters dread it, farmers welcome it, as the rains and frosts crumble the phosphatic rocks and add them to the mass of *débris* that forms our soil.

Now let us take a test tube and put into it lime, potash, soda, iron, silicon, or sand, and phosphorus, add to it a grain of corn, and watch results. Under suitable conditions of warmth and moisture the grain will sprout, but when the store of food laid up in it is exhausted our little plant will die. It is obvious that something else is needed for a soil, and analysis shows that it is nitrogen, the gas that forms nearly four fifths of our atmosphere—a gas useless, as such, to animals, but essential to plants. Nitrogen is abundant in Nature. Besides being nearly four fifths of the air, it forms twenty-two per cent of nitric acid, forty-five per cent of saltpeter or niter, eighty-two per cent of ammonia, and about twenty-five per cent of sal ammoniac. Plants can not use nitrogen in its pure form, but one or another of these forms will be found in the soil, whence it may be extracted.

Now we have the chief articles of plant food, and it is necessary to know how they are to be used. A plant usually consists of two parts, one that appears above ground, bearing branches, twigs, and leaves, and another that remains below ground. It is this latter that concerns us now, and it is worth study. This lower part consists of a number of twigs called rhizomes, from which proceed a vast number of fine, threadlike rootlets, and these are the mouths of the plant, through which it draws nourishment from the earth about it.

Before any living thing can use nourishment from without, it must be dissolved, and this solution requires much preparation at times. Men, and other animals with a wide range of food stuffs, effect this by the secretions of the digestive organs; but most plants have no digestive apparatus, strictly speaking, and were

they supplied with an abundance of the foods they most need, they would starve unless the food were in a suitable state for absorption.

The way in which Nature effects this solution is the key to many of her secrets, and it has been understood only within the past few years. If we have a piece of meat freshly taken from an animal we find it firm, coherent, and almost odorless. If it be put into a warm, moist chamber for a few days a great change comes over it, and it becomes soft, offensive in odor, and liable to fall to pieces. We say that it is rotten or putrid. If a bit of it be put under a microscope, it is seen to be teeming with bacteria, and these are responsible for the decay. Now, if a specimen of earth be examined, we find that it contains bacteria, that attack all kinds of organic matter, tearing it to pieces to get their food, and making many different things out of what is left. There is one sort of ferment that grows in apple juice and splits the sugar into alcohol and carbonic acid, forming "hard cider," and if the fermentation stops at this point the well-known drink results. However, there is another ferment called "mother of vinegar" that may get in, and, if so, a different kind of fermentation is started that forms acetic acid instead of alcohol; or the bacteria of decomposition may come in and the whole go back to its elements.

There is a wonderful provision of Nature shown in these stages. The bacteria—the organisms that produce decay—can not live in a strong sugar solution, but the ferments, like common yeast, can live in it, and they split the sugar into alcohol, carbonic oxide, and other things. In these another set can live, and when the first have died of starvation or from the alcohol they form, the second set step in and turn the weak alcohol into acetic acid. Acetic acid is a preserving agent, as our sour pickles show, but if it is not too strong there are some organisms that can live in it, and the whole process ends in decay. Now, it should be noticed that each of these organisms paves the way for the next by converting an unsuitable food stuff into a suitable one.

This familiar example indicates the lines on which Nature works. It is the same everywhere, and shows the advantage of specialization, of allowing some one with peculiar facilities for performing an act to do that exclusively, that others may profit by his skill. So long as each man sought and killed his food, cooked his meals, made his own clothing, weapons, and implements—in a word, lived alone—advance was impossible. It was only when he who was most skillful with the needle made garments for the hunter in exchange for a haunch of venison, that the hunter could practice marksmanship, and the tailor design a new cut for the mantle with which the warrior might dazzle the daughter of the arrow maker.

It is the same in Nature. Some organisms possess powers of elaborating certain materials of which others are quick to avail themselves. Plants can manufacture starch, an article needed by animals, but of which their own capacity, so far as producing it is concerned, is very limited, and thus animals find it advantageous to avail themselves of these stores instead of taxing their own resources. Similarly, plants need the organic matters of the animal bodies, and wise agriculture supplies carbon, nitrogen, and other articles of food in the shape of animal and vegetable refuse. But this matter requires digestion; it must be made soluble before it can be absorbed, and but few plants can effect this solution unaided. The "Venus's flytrap," the sundew, the wonderful "carrion plant," and others, are equipped with elaborate apparatus by which they are enabled to capture, kill, and literally digest the insects that supply them with nitrogeneous food, but these are exceptional cases. Nature usually employs other agents.

The action of bacteria in causing decay has been said to be in general similar to fermentation—that it is effected by the bacteria in seeking their food. If oxygen be abundant, putrefaction occurs; if it be scant or absent, then fermentation takes place, for the tiny organisms require oxygen, and, if the air fails them, they pull to pieces the organic matters near them to obtain it. In doing this they get the nitrogen into such shape that the plants can use it, and thus digest their food for them. All organic matter contains carbon, hydrogen, and oxygen as a general rule, and to these are often united phosphorus, sulphur, nitrogen, and others, making very complex arrangements, veritable houses of cards, in fact, only held together by the strange power of life. When a leaf falls or a bird dies, some of these combinations are broken, and then the bacteria and other lowly organisms have full sway, for living matter is impregnable to all save a few of them. As oxygen or something else is taken out of the complex molecules, the compound falls to pieces, but as in the kaleidoscope the bits of colored glass tumble into endless varieties of symmetrical figures, so do the atoms fall into new combinations. If the keystone of an arch be removed, the stones fall apart; but atoms, unlike bricks or stones, can not stand alone as a rule; they must be united to something, and so, as soon as old associations are dissolved, new ones are formed. These new ones are those needed by plants, and thus is plant food digested.

The term "plant food" has been frequently used, and should now be distinctly explained, for merely stating the chemical elements is not describing the food. When a physician tells a nurse to feed a patient he does not order so much carbon, nitrogen, phosphorus, and the like, but specifies a soup, certain

vegetables, and so on, detailing every particular; and the same should be done for vegetable invalids.

In medical practice a condition is recognized that is called scurvy. It is not exactly starvation, but is produced by lack of some food materials usually supplied by fresh vegetables. If scurvy appears at sea, no amount of meat, bread, cakes, or pastry will stop it; vegetables, and they only, will stay it. Sometimes a similar condition prevails among crops: some ingredient in a soil is lacking, and the others may be supplied indefinitely without giving the desired relief. To this may be attributed much of the fault found with fertilizers; for if the soil does not need a particular compound it is useless to apply it, and an excellent fertilizer is often blamed for not producing a crop on land already overstocked with it and crying for something else.

Let us suppose a field on which cotton has been grown for many successive years until it has become exhausted. Analysis shows that a crop yielding one hundred pounds of lint to the acre removes from the soil:

Nitrogen	20.71	pounds;
Phosphoric acid	8.17	"
Potash	13.06	"
Lime	12.60	"
Magnesia	4.75	"
Total	59.29	"

The weight of the whole crop from which these figures were taken was eight hundred and forty-seven pounds, so that cotton exhausts land less than any staple crop, if the roots, stems, leaves, etc., be turned under and only the lint and seed be removed. Of these the lint (one hundred pounds) takes 1.17 pound from the soil, and the seed 13.89 pounds, making 15.06 pounds net loss.[47] But ignoring returns that may be made in the shape of cotton-seed meal, etc., and lime, with which our soils are abundantly supplied, we see that nitrogen, phosphoric acid, and potash have been removed. Suppose the owner puts bone meal on his exhausted land: the phosphoric acid in the bone will supply one need, and an improvement results. On the strength of this, bone meal will be loaded into the soil again, and let us suppose the deficit not yet made up, the crop again shows improvement. Now, phosphoric acid abounds in the soil, though the deficiency in nitrogen and potash has become steadily greater; so, when the customary bone

meal is applied, the crop falls back, because the plants are starving for potash and nitrogen. They are like scurvy-smitten sailors, but many thoughtless farmers would attribute the decline to the maker of the bone meal, and say that its quality was not so high as formerly—an opinion similar to that of a sea captain who would ascribe to the poor quality of salt beef an outbreak of scurvy on his vessel.

As crops of any description extract potash, nitrogen, and phosphoric acid from soils, the question how they are to be replaced is an important matter, and its answer may be most readily found by studying Nature's methods. In parts of the Old World there are fields that are fertile in the extreme after thousands of years of tillage, and it is apparent that mere cultivation does not prove injurious. The tropical forests have something growing wherever a plant can find foothold—a population in which the struggle for food is secondary to that for light and air, and yet the soil supporting this vegetation is marvelously rich. Every leaf that falls remains where it fell until in the warm, moist, half-lighted forest it becomes a little heap of mold. The bacteria of decomposition require warmth and moisture for their life; light is deleterious to them, but they thrive in the dense shade of the jungle. The tangled web of roots, weeds, and vines retains the rainfall, retarding evaporation, and preventing both droughts and freshets. Receiving dead and broken leaves, boughs, and other vegetable products, and spared the washing of violent torrents, the forest is inestimably fertile.

On a smaller scale this goes on universally. The annual weeds, deciduous leaves, and such matter, fall prey to molds and bacteria, by which they are made soluble. Snows and rains bear the products into the soil, and there other bacteria, clustering around the roots, form the acids needed to complete solution. Every one knows that "well-rotted" manure is better than that which is fresh, and many wonder at this, but the reason is apparent. In feeding delicate patients, physicians often prescribe predigested foods or the digestive ferments to aid enfeebled assimilation; and similarly the manures that have been thoroughly acted on by bacteria, or containing those capable of producing the matters that plants need, are of most value for nourishing vegetation.

In producing an article of any sort, the cheapness and ease with which it can be made is largely dependent on the shape in which the raw material reaches the factory. If a foundry can procure iron that needs only to be melted and cast, the owner can fill his orders more readily than would be possible if he had to reduce the metal from the ore; and Nature uses this principle over and over again. The importance of nitrogen to plants and its abundance in Nature have been mentioned, but it has also been said that plants can not use it directly, as most

animals do with oxygen. The tiny bacteria intervene, and this they do in two ways: first, by causing decay of animal or vegetable matter containing nitrogen, and by this decay producing substances that plants can absorb; and, secondly, by producing little nodules or "tubercles" on the rootlets, through which the plant can take up nitrogen.[48] Now, when a plant is sated with nitrogen, it ceases to form these tubercles, and their formation is a sure sign that the plant is craving this article of food. When it is supplied, and its own life is ended, these form reservoirs from which other plants may be supplied, as new castings may be made from broken wheels. The great value of "green manuring" depends on the store of available nitrogen so laid up, but it is open to failure in one direction. The liability of fermentation to go to the acid stage from contamination with acid-forming ferments has been mentioned, an accident the possibility of which is impressed on us from time to time by sour bread; and similarly the organic matter turned under may undergo acid fermentation, rendering the ground "sour" and unfit for cultivation.

The limits of this paper forbid the consideration of special fertilizers, but from the general principles laid down the rules for any special case may be deduced. A soil should contain a sufficient amount of potash, soda, lime, iron, and a few other minerals; phosphoric acid, nitrogen, organic matter, and, for some special crops, some other ingredients may be needed. When the soil needs renewing, there are two ways of accomplishing it. One way is to guess at what is needed; to buy fertilizers at high prices, without inquiring whether the soil needs the substances in that particular brand or not. Though very common, this is not a good plan. It is as though a physician were to give a patient any drug that was convenient, without inquiring into the disorder or the needs of the system, and it is followed by much the same result. That acid phosphate gave Farmer A a good crop, is no reason that Farmer B's land is also deficient in phosphorus. The same reasoning would teach that a heart stimulant that rouses a patient from shock would benefit one in danger of apoplexy, where the least increase in heart force might be fatal. A physician using such reasoning as the basis of his practice would not be considered a master of his art; and were he to attribute the fatal outcome of his logic to the poor quality of his stimulant, he would display criminal ignorance of drugs as well as disease; yet it is very common to see farmers put guano on a soil begging for potash, and then heap execration on the head of the dealer who sold the guano when the crop failed. To revert to a simile used above, a captain must not blame the salt pork for scurvy.

The other way to buy and use fertilizers is to ascertain what a certain crop needs;

then find out whether these be in the soil, and to what extent. With these data the deficiency may be made good without the wasteful cost of the former method. State and Federal Departments of Agriculture furnish their aid freely and gladly, and already the signs are seen of the day when agriculture will take its place among the semiexact sciences, and the present haphazard methods will become obsolete.

SKETCH OF AUGUST KEKULÉ.

"This news," said Herr H. Landrelt, president, announcing Kekulé's death in the German Chemical Society at Berlin, "will be received with sorrow not only by our society but by the whole chemical world. Science has again lost one of its greatest representatives, one of those extremely rare spirits who were called upon to found a new epoch in it and push it mightily forward."

FRIEDRICH AUGUST KEKULÉ was born at Darmstadt, September 7, 1829, and died, after a long illness, at Bonn, July 13, 1896. He was originally destined by his father for the profession of an architect; and some houses, he told his students in a festival address, still existed (in 1892) in Darmstadt of which he drew the plans when, a youth, he was attending the gymnasium. The leading events of his life were very tersely told by himself in an address responding to an ovation from the students of the University of Bonn on the twenty-fifth anniversary of his professorship there; a translation of which, from the *Kölnische Zeitung*, was published by Mr. J. E. Martin in Nature, June 30, 1892.

At Giessen, he said, where he went to study architecture, he attended Liebig's lectures, and was thereby attracted to chemistry. But his relatives would not at first hear of his changing his profession, and he was given a half-year's grace to think over it. He spent his time in the Polytechnicum at Darmstadt. His first teacher in chemistry at Darmstadt was Moldenhauer, the inventor of lucifer matches. His leisure time was spent in modeling in plaster and at the lathe. He was then permitted to return to Giessen. "I attended," he said, "the lectures, first of Will and then of Liebig. Liebig was at work on a new edition of his letters on Chemistry, for which many experiments had to be carried out. I had to make estimations of ash, of albumen, to investigate gluten in plants, etc. The names of the young chemists who helped Liebig were mentioned in the book, among them mine. The proposal was then made to me, just at the time Liebig intended to make me his assistant, that I should go for a year abroad, either to Berlin, which was at that time to Giessen a foreign land, or to Paris. 'Go,' said Liebig, 'to Paris; there your views will be widened; you will learn a new language; you will get acquainted with the life of a great city; but you will not learn chemistry there.' In that, however, Liebig was wrong. I attended lectures by Frémy, Wurtz, Pouillet, Regnault; by Marchandis on physiology, and by Payen on technology. One day, as I was sauntering along the streets, my eyes encountered a large poster with the

words *Leçons de philosophie chimique par Charles Gerhardt, ex-professeur de Montpellier*. Gerhardt had resigned his professorship at Montpellier, and was teaching philosophy and chemistry as *privat docent* in Paris. That attracted me, and I entered my name on the list. Some days later I received a card from Gerhardt; he had seen my name in Liebig's Letters on Chemistry. On my calling upon him he received me with great kindness, and made me the offer, which I could not accept, that I should become his assistant. My visit took place at noon, and I did not leave his house till midnight, after a long talk on chemistry. These discussions continued between us at least twice a week for over a year. Then I received the offer of the post of assistant to von Plauter, at the Castle of Reichenau, near Chur, which I accepted, contrary to Liebig's wish, who recommended me as assistant to Fehling, at Stuttgart. So I went to Switzerland, where I had leisure to digest what I had learned in Paris during my intercourse with Gerhardt. Then I received an invitation from Stenhouse, in London, to become his assistant, an invitation I was loath to accept, since I regarded him, if I may be allowed the expression, as a *Schmierchemiker*. By chance, however, Bunsen came to Chur on a visit to his brother-in-law, at whose house I first met him. I consulted Bunsen as to Stenhouse's offer, and he advised me by all means to accept it. I should learn a new language, but I should not learn chemistry. So I came to London, where as Stenhouse's assistant I did not learn much. By means of a friend, however, I became acquainted with Williamson. The latter had just published his ether theory, and was at work on the polybasic acids (in particular on the action of PCl_5 on H_2SO_4). Chemistry was at one of its turning points. The theory of polybasic radicals was being evolved. With Williamson was also associated Odling. Williamson insisted on plain, simple formulæ, without commas, without the buckles of Kolbe or the brackets of Gerhardt. It was a capital school to encourage independent thought. The wish was expressed that I should stay in England and become a technologist, but I was too much attached to home. I wished to teach in a German university. But where? In order to get acquainted with the circumstances at several universities, I became a traveling student. In this capacity I came, among other universities, to Bonn. Here there was no chemist of eminence, and hence there were no prospects. Nowhere did there seem so much promise and so great a future as at Heidelberg. I could ask no help of Bunsen. 'I can do nothing for you,' he said, 'at least not openly. I will not stand in your way, but more I can not promise.' I fitted up a small private laboratory in the principal street of Heidelberg at the house of a corn merchant—Gross, by name—a single room with an adjoining kitchen. I took a few pupils, among whom was Baeyer. In our little kitchen I finished my work on fulminate

of silver, while Baeyer carried out the researches, which subsequently became famous, on cacodyl. That the walls were coated thick with arsenious acid, and that silver fulminate is explosive, we took no thought about. After two years and a half I received a call to Ghent as ordinary professor. There I stayed nine years, and had to lecture in French. With me to Ghent came Baeyer. Through the kindness of the then Prime Minister of Belgium, Rogier, I obtained the means to establish a small laboratory. I had there with me a number of students, among whom I may name Baeyer, Hübner, Ladenburg, Wichelhaus, Linnemann, Radzizewski. There was not so much a systematic course of instruction as a free and pleasant academic intercourse. After nine years' work I received the call to Bonn." Professor Kekulé concluded his address with some account of his work at Bonn, and of the great attention he had always received from his pupils. For a full account of Kekulé's scientific career and achievements, we are indebted to the memorial address made by President Landelt to the German Chemical Society on the occasion of his death, of which we translate the more important passages from the *Berichte*:

"The works which Kekulé has left behind him belong, as we all know, to the bases of all chemistry. His teachings have so passed into our flesh and blood that it seems almost superfluous to remind a circle of professional chemists of them. I shall be able to present only in the most general outlines this evening the immense influence which the dead master has exercised upon science; a complete view of all his labors is a subject for a biography, which we must wait for.

"Kekulé's scientific work began in 1854, with the discovery of thiacetic acid, by which he at once separated from the old school of chemistry that was still prevailing, and, founding a new one, revealed himself as an adherent of the new doctrine of types. After his habilitation at Heidelberg, which followed in 1856, came the essay on fulminating mercury, in which the view so important for the future was expressed, that to the three typical combinations of chlorhydrogen, water, and ammonia, hitherto recognized, might be added a fourth, marsh gas. In the next essay, on binary combinations and the theory of polyatomic radicals, he put forward the conception of mixed types, and first reached the knowledge of various atomicity or valency of the radicals. These researches were continued, and there appeared shortly afterward, in the spring of 1858, the two great treatises which have since exercised so powerful an influence on chemistry—that on the constitution and metamorphoses of chemical combinations, and that on the chemical nature of carbon. In these theses Kekulé passed from the

valency of the radicals to that of the elements themselves, and showed that the composition of all those compounds that contain one atom of carbon lead to the conclusion that that element is quadrivalent; and that, further, the relations of combination of a complex of carbon atoms are explainable if we suppose that the latter are mutually bound by a certain number of their four unities of attraction. This idea was suggested very carefully, and the words which the author added at the end of his essay read very curiously to-day: 'Finally, I think I ought still to insist that I attach only little value to speculations of this sort. Since one delving in chemistry must once in a while, in the lack of exact scientific principles, content himself with probabilities and temporary hypotheses, it seems proper to communicate these conceptions, because, as it appears to me, they furnish a simple and fairly general expression for the newest discoveries, and because, therefore, the use of them may assist in the discovery of new facts.' How diffident the words sound, and how far have the expectations been exceeded! We all know that the theory of valency is to-day the leading guide through all our science; and, although another investigator had a share in its origination, no one disputes that its main foundation and its eminent value in organic chemistry are primarily due to Kekulé's idea of the quadrivalency of carbon.

"After he was called to the University of Ghent, in 1858, Kekulé exhibited an indefatigable activity. He began the great series of investigations of the organic acids which, beginning with succinic acid, malic acid, and tartaric acid, and extending afterward to many others, have given complete conclusions as to the nature of these bodies. Contemporaneously, in 1860, appeared the first number of the *Lehrbuch der organischen Chemie*, which was soon followed by other numbers, so that the whole first volume was completed in 1861. All his fellow-chemists who are acquainted with the events of that period will remember the enthusiasm with which the work was received. For the first time, in place of the former system of organic chemistry based on the old radicals of Berzelius, a system of treatment appeared which in the dress of the theory of types had the doctrine of valency as its foundation, and exposed the construction as well as the isomeric relations of the numerous carbon compounds with wonderful clearness. The work, the first two published volumes of which contained the substances designated by Kekulé as the fatty compounds, is still recognized as the prototype of many text-books that followed it.

"In 1855 Kekulé put forth the second of his great theories. First in the Bulletin of the Chemical Society of Paris, and afterward in fuller form in Liebig's *Annalen*, appeared the essay, Researches among the Aromatic Compounds, in which he

showed that the substances so designated all contain six or more atoms of carbon, and that they could be described as derivatives of the simplest of them, benzene. He proposed two hypotheses to explain the constitution of this substance, one of which, the only one afterward pursued, supposed that the six carbon atoms are associated in a ring, and alternately linked by one and two valencies. By replacing the hydrogen atoms corresponding to each carbon atom by other elements or radicals one could arrive at the knowledge of the constitution of a large number of aromatic bodies which now figure as benzol derivatives. These considerations led, however, to another question—namely, whether or not the supplied places of the six hydrogen atoms are chemically equivalent. The question of space relations in chemistry first came up in connection with this investigation, and Kekulé at once endeavored to solve it. All these ideas were, however, expressed at first with reserve, and this essay closes with the words, 'I place no more value on these views than they are worth, and I believe that much labor must still be applied before such speculations can be regarded as anything else than more or less elegant hypotheses; but I believe, too, that at least experimental speculations of this kind must be used in chemistry.'

"In this case, again, Kekulé's modest expectations have been surpassed. The wonderful results that have accrued from the benzol theory are patent to all of us. We know that it was the instigation to the carrying out of an innumerable multitude of researches which are still pursued with undiminished industry. Rarely has a thought exercised so fructifying and forwarding an influence on chemistry, and so redounded to the advantage of both pure science and art. Thankfulness for this gift, as you know, prompted our society to honor the author of the benzol theory and the twenty-fifth year of the announcement of it by a public festival; and the Kekulé celebration, which took place in this house on the 11th of March, 1890, is memorable to all for the brilliant and witty speech with which the master responded to the many addresses made to him. It is preserved in our reports (*Berichte* 23, 1892), and the repeated reading of it always affords rich enjoyment."

Kekulé assumed his last position, as professor at the University of Bonn, in the fall of 1867. He there devoted his attention for a period to the erection of a new institute building, but it was not long before numerous works began again to appear—some of them by himself alone, like the important investigation of the condensation products of aldehyde; and others in co-operation with his many students. The continuation of his *Lehrbuch* was taken in hand at the same time.

In 1867 he gratified his fellow-chemists by the publication of the first volume of his Chemistry of the Benzol Derivatives. This was followed from 1880 to 1887 by single numbers, prepared with the help of co-workers, of the second and third volumes.

Prof. F. R. Japp, in the Kekulé memorial lecture before the Chemical Society of London, speaking of Kekulé's residence in that city, September, 1897, said that he always acknowledged the influence which Liebig and Odling and Williamson, with whom he became acquainted in London, exercised on the formation of his opinions. Kekulé's theories, Professor Japp said, were based on Gerhardt's type theory; on Williamson's theory of polyvalent radicals, which by their power of linking together other radicals render possible the existence of multiple types; and Odling's theory of mixed types, which was a deduction from Williamson's theory. Less consciously, perhaps, his opinions were influenced by E. Frankland's theory of the valency of elementary atoms, and by Kolbe's speculation on the constitution of organic compounds. Kekulé gathered together the various ideas which he found scattered throughout the writings of his predecessors, added to them, and welded the whole into the consistent system which forms our present theory of chemical structure. In 1857, in the course of a memoir on the constitution of fulminic acid, he gave a tabular arrangement of compounds formulated on the type of marsh gas, this being the earliest statement, though put forward only in an imperfect form, of the tetravalency of carbon. In the same year he published an important theoretical paper On the So-called Conjugated Compounds and the Theory of Polyatomic Radicals, which contains a complete system of multiple types and mixed types. In 1858 the celebrated paper, On the Constitution and Metamorphoses of Chemical Compounds, and on the Chemical Nature of Carbon, appeared. It embodies the fully developed doctrine of the tetravalency of carbon, together with Kekulé's views on the linking of atoms and on the valency of such chains of atoms, the foundation on which our modern system of constitutional chemistry rests. In 1865 Kekulé put forward his well-known benzene theory—pronounced by Professor Japp the crowning achievement, in his hands, of the doctrine of the linking of atoms, and the most brilliant piece of scientific prediction to be found in the whole range of organic chemistry. The conception of closed chains, or cycloids, which he thus introduced, has shown itself to be capable of boundless expansion.

Kekulé's students all speak admiringly of his qualities as a teacher. The memorialist of the German Chemical Society said: "All of us who have attended

his lectures or heard him in other places will ever remember what a teacher Kekulé was. With incomparable lucidity and sometimes with the happiest humor, he could go playfully through the theme he was considering, masterfully presenting it in new and often surprising aspects. The charm of his personality affected all who came in contact with him; it was the geniality which shone out of his whole being, and involuntarily commanded admiration. Numerous pupils flocked to him, and many of those who to-day fill chairs of chemistry in Germany and other countries have made his name highly honored."

Professor Thorpe, of London, who spent a little time in Kekulé's laboratory, describes him as having been one of the very best expositors, with the single possible exception of Kirchhoff, to whom it had been his lot to listen. As a laboratory teacher he was excellent. He was a most severe judge of work, striving to exact the same high manipulative finish, the same neatness and order, which he invariably bestowed on everything he did, and he was absolutely intolerant of anything slovenly or "sloppy." "But it was as a lecturer that he was seen at his best. He was singularly luminous as a thinker, a close and accurate reasoner, with a remarkable power of concentrated expression.... His language was apt and well chosen, and his delivery easy and natural"; and his whole address showed that every detail had been carefully considered.

At a distance of thirty years, Professor Dewar said, at the London memorial meeting, that to look back and call to mind the presence and personality of the great chemist as he knew him was indeed a pleasure. He was a man of noble mien, handsome, dignified, and yet of a homely and kindly disposition. He was a severe critic, having a haughty contempt for the accidental and bizarre in scientific work. His originality and suggestiveness seemed endless, so that he had no need to commit trespass or to follow just in the wake of other people's ideas. "Everything that passed through the Kekulé alembic was indeed transmuted into pure gold. His precision of thought and diction rendered his papers profoundly suggestive to other workers."

"The last years of the master's life," his German eulogist says, "were often troubled by illness, but there were not wanting bright days which the love of his students and colleagues prepared for him." Such a one was the celebration of the twenty-fifth anniversary of his professorship at Bonn, June 1, 1892, in which the students and officers participated with cordial unanimity. The ceremony began in the morning with an enthusiastic ovation by the students. The chemical theater was decorated with plants; the benzene hexagon was figured on the blackboard with garlands of flowers, in the midst of which the letters A. K. were wrought in

a monogram of roses. Alfred Helle, one of the chemical students, delivered a felicitous address, in which he congratulated his fellow-students on being privileged to sit at the feet of the greatest of living chemists, after which three cheers were given to the professor. Kekulé responded to the offering in an address giving some of the details of his life, from which we have already quoted. Kekulé's personal staff and the officers of the university then presented their congratulations.

In the evening the students honored him with a torchlight procession, it being the third time he had received this, the most conspicuous honor which is bestowed by German students. The first occasion was in 1875, when he declined the professorship at Munich; the second was in 1878, when he was rector of the university, and was given in celebration of the restoration of unity among the students, after a long period of disunion. Among the torchbearers on that occasion was the present Emperor of Germany.

During the later period of his life Kekulé was comparatively sterile. Those who knew him, however, Professor Thorpe says, "would be the first to affirm that this seeming apathy sprang from no natural indifference. There is no doubt that he suffered, even in the early period of middle life, from the intense stress and strain of his mental labors prior to the Ghent period. He too surely exemplified the sad truth of Liebig's saying that he who would become a great chemist must pay for his pre-eminence by the sacrifice of his health. There is reason to know that it was the consciousness of failing power which prevented him from finishing much to which he had put his hand, and that his fastidiousness and his sense of 'finish,' amounting almost to hypercriticism, restrained him from publishing much which he realized fell short of his ideal."

The last time Kekulé's name was brought before the public was on the occasion of the renewal of the ancient title of nobility of his family, as August Kekulé von Stradowitz.

Editor's Table.

A VOICE FROM THE PULPIT.

We called attention last month to a weak attack on the doctrine of evolution by a certain Mr. A. J. Smith, Superintendent of Public Schools in the city of St. Paul. The only thing which gave any consequence to the deliverance in question was that it was addressed to a large gathering of public-school teachers, who might possibly have been unduly influenced in their appreciation of it by the speaker's official position. We are glad now to learn that, very shortly after the publication of Superintendent Smith's address, an excellent statement of the true relation of the doctrine of evolution to education was made in one of the city pulpits by the Rev. S. G. Smith, who did not boast, as the superintendent had done, of having made an exhaustive study of the subject, but who, nevertheless, showed that he had a grasp of it which the other altogether lacked. The Rev. Mr. Smith's discourse would have merited attention wherever it might have been delivered; but, considered as a pulpit utterance, it seems to us to possess a special and very encouraging significance. We need hardly say that the pulpit has not always been friendly to broad scientific views, but in this case it has spoken with a candor, a breadth, and an intelligence which the lecture platform can not do more than equal, and which it would certainly be too much to look for in all our colleges.

"The law of evolution," said the reverend gentleman, "is as universal in its application as the law of gravitation. It holds that in every realm the simple tends to become complex, and that the complex is more stable than the simple. Motion and matter have a history in which the simple and the indefinite take on variety of organization and definiteness of adaptation." This is a statement in which the author of the Synthetic Philosophy would probably have very little change to suggest. Mr. Smith does not, like so many who discuss the subject in a superficial manner, confound evolution with Darwinism. Darwinism, he recognizes, may, in its particular explanations as to the origin of species and the descent of life, be in error; but evolution is universal in its scope, and can only fail if it can be shown that the fundamental postulates on which it rests, such as the instability of the homogeneous, the continuity of motion, the law of rhythm, etc., are not to be depended on. Must a person have made the circle of the sciences and comprehended all knowledge before he can reasonably profess a

belief in evolution? No, says Mr. Smith; when the foundations of a doctrine have been clearly laid, when they have been tested by many different investigators from many different points of view, and when these, almost without exception, affirm that the doctrine is not only in harmony with, but lends a new and deeper significance to, the several orders of fact with which they are individually concerned, any person of ordinary intelligence is justified in considering that doctrine as satisfactorily proved and giving it his personal adhesion.

What chiefly excited the ire of Superintendent A. J. Smith was the contention of evolutionists that the modern child reflects the earlier stages of human development. He asked his audience if they really thought the children of to-day were young savages, and quoted Emerson and Longfellow as authorities on the question. The Rev. S. G. Smith takes up the point and expresses himself as follows: "When it is stated that the child has many points of contact with primitive man, it is not meant that the child is a savage, but that 'in its immaturity' we can learn much respecting it from the study of child races. The child has neither the virtues nor the vices of the savage, but he has many of the mental characteristics. Embryology does not teach that in prenatal life the child passes into the form of every animal in a menagerie, but that its life passes through the stages that mark the great subdivisions of all life. Nor do the comparisons of the child with primitive man imply that he must pass through all the activities of savage races, but that the development of his faculties, the tendencies of his desires, the state of his ignorance, all illustrate the history of the development of the race. Primitive man may be understood by a study of the child, and, conversely, the child may be illustrated by primitive man."

It must be borne in mind that the child is in constant contact with its elders, that it is subject to the restraints which they impose, and that it lives more or less in an atmosphere of affection and care. There is excellent reason, therefore, why it should not resemble primitive man in all points. Its daily life is really controlled and guided by a higher power. In some cases there is even too much control and guidance; the conditions are made too artificial, and the development of the child's nature suffers in consequence. When the age of manhood or womanhood is reached there is something lacking, precisely because enough scope was not left for the primitive or, as we may very properly say, the "savage" instincts of childhood. A great French writer, Joseph de Maistre, quotes a popular saying to the effect that "spoilt children always turn out well."[49] So far as there is any truth in it, the explanation is that the spoilt child is one that has a great deal of its own way, and is left to work out the savage and so acquire a sounder foundation

for its future life. In how many of us are there not chained savages that might have made their escape in earlier years if they had only been allowed! It is a dangerous thing to try to make little angels of children.

The Rev. Mr. Smith is quite right in what he says as to the predominance of the imagination in children, this being another strong point of resemblance to primitive man. "The beginnings of history and institutions," he truly says, "can only be understood when we remember that races in their early development do not have clearly marked activities of imagination, reason, and memory. They mix the three. So legends, myths, and heroics are earnest efforts of the undeveloped mind to make objective the truth, and are not clumsy lies at all." Applying this to the child, the conclusion is that "he must be fed through his imagination or he will not grow." A very imaginative child is apt to be accused of falsehood, when he simply fails to distinguish between things imagined and things remembered. Neither the child nor the savage can concentrate his attention, and to force either to do so beyond a certain very limited measure is simply to injure and deform such natural powers as he possesses. The amount of mischief which a dogmatic and over-logical teacher, wholly ignorant of the psychology of the child, can do is beyond all calculation.

It is needless, however, to pursue the parallel further, though the Rev. Mr. Smith very properly carries it into the region of morals, where it is no less close than in that of intellectual action. There is another interesting aspect of evolution which the reverend gentleman glances at, and that is its bearing on general courses of study. History and literature, considered as departments of research, it has largely transformed by substituting for conventional categories and abstract notions the perception of a genetic process pervading all the works of the human spirit and linking them into an organic unity. In conclusion, we may observe that, if Superintendent A. J. Smith had not made some foolish remarks in a rather ostentatious manner, it is probable the Rev. S. G. Smith would not have delivered the excellent discourse on which we have commented, and which we feel sure will far outweigh in general effect the performance which called it forth. The conclusions to be drawn are the pleasing ones that good may sometimes come out of evil, and that a free pulpit is admirably adapted to guard the interests of liberty and common sense.

LESSONS OF ANTHROPOLOGY.

The address delivered at the last meeting of the British Association by the president of the Anthropological Section contained nothing that was strikingly novel—it is not every year that striking novelties can be announced—but it dealt in an interesting manner with several phases of a most important subject. The speaker, Professor Brabrook, took the position that the order of the universe is expressed in continuity, not cataclysm, and that this principle will be found illustrated in every branch of anthropological research, in direct proportion to the completeness of the data obtained. He admitted the vastness of the gap which still separates the remains of palaeolithic from those of neolithic man, but expressed the belief that further explorations would bring intermediate relics to light. To quote the speaker's words: "The evidence we want relates to events which took place at so great a distance of time that we may well wait patiently for it, assured that somewhere or other these missing links must have existed, and probably are still to be found."

Reference was made to the labors which are now being usefully expended in gathering what is called the folklore of various communities, and to the result which continually appears with fuller evidence, namely, that the tendency of mankind everywhere is to develop like fancies and ideas at a like stage of intellectual development. Full of detail as these stories are, they are found to contain but a few primitive ideas; and it seems not improbable that to a large extent they are essentially Nature myths. Mr. Brabrook happily quotes Lord Bacon's description of such narratives as "sacred relics, gentle whispers and the breath of better times." The "better times" are a part of the general system of myth; but who will deny that there is a special charm in these early documents of our race? "Let one of our literary exquisites," said a thoughtful French writer, "try to write a fairy tale which shall neither be a pretentious apologue nor a tiresome and transparent allegory, and he will soon feel that mere cleverness does not suffice to create these marvelous narratives, and will conceive a just admiration for those who constructed them, that is to say, everybody and nobody."

The progress of anthropology, according to the president of the section, seems more and more to confirm the theory adopted by Fustel de Coulanges in France and Spencer in England, that the belief in spirits lies at the basis of all religious systems. We thus see, to use his words, "that the group of theories and practices

which constitute the great province of man's emotions and mental operations expressed in the term 'religion' has passed through the same stages, and produced itself in the same way, from rude early beginnings, as every other mental exertion." Mr. Brabrook mentions a work lately published by "a distinguished missionary of the Evangelical Society of Paris," the Rev. Mr. Coillard, in which an account is given of the superstitions prevailing among the natives of the upper Zambesi. The reverend gentleman tells of their belief in witchcraft, and gives a story of a young woman who was condemned to penal labor on suspicion of having bewitched, or tried to bewitch, another young woman who had taken her husband from her; the evidence of the crime being found in a dead mouse, which had been discovered in the second young woman's chamber. The missionary says: "She was made a convict. A few years ago she would have been burned alive. Ah, my friends, paganism is an odious and a cruel thing!" On which the president of the Anthropological Section observes: "Ah, Mr. Coillard, is it many years ago that she would have been burned alive or drowned in Christian England or Christian America? Surely the odiousness and the cruelty are not special to paganism any more than to Christianity." This is much to the point. If witchcraft is no longer a recognized crime in England or America, it is not because these lands are Christian, but because science is mixed with their Christianity. Even missionaries ought to know this.

A great many different sciences are grouped under the name "anthropology," but they all have their rallying point in man, whose nature and history they seek to explore. The fact is that all sciences should have the same rallying point; and we trust that the greater interest which is visibly being taken year by year in anthropological studies will tend to humanize in a beneficial degree the whole circle of human knowledge.

AN EXAMPLE OF SOCIAL DECADENCE.

That the incessant encroachment of the Government upon the rights of the individual will produce social decadence is a truth that most Americans have yet to learn. With a light heart they are constantly approving scheme after scheme for social regeneration that involves some restriction upon freedom, or an increase of taxation, or both. It is not perhaps singular that the history of similar schemes in the past should possess no lesson for them. When President Eliot, of Harvard University, says that the experience of the Italian republics has no value for us, it is not to be expected that persons with less capacity to interpret the records of other times should attach little or no importance to them. But they

ought not most certainly to maintain the same attitude toward the experience of the nations of to-day. It is to blind their eyes to what does not rest upon hearsay or upon dubious documents—to what admits of the clearest demonstration at the hands of living witnesses.

For this reason we urge upon all students of social science the study of the condition of the inhabitants of the black-earth region of Russia. In that field, one of the largest and most fruitful in the world for investigation, they will find the amplest evidence of the frightful havoc wrought by the abridgment of individual freedom and the seizure of private property in the form of taxes for public purposes. If it be said that Russia is an autocracy, and can not therefore furnish instruction to a democracy like the United States, the answer is easy, if not obvious. Despotism, like gravitation, is the same all over the world. It makes no difference in the long run whether a law abridging freedom issues from the palace of a czar or from the legislative halls of a popular assembly. The individual objecting to it is obliged to regulate his life, not in accordance with his own notions, but in accordance with the notions of some one else. It makes no difference, either, whether taxation is imposed by an imperial edict or by a legislative vote. The citizens that have to bear it against their will contribute money for purposes that some one else only approves of. The only difference between Russia and the United States is that this kind of despotism has been carried to much greater lengths in one country than in the other. If, therefore, we can find out what the effect has been in Russia, we will be able to predict what the effect will be in the United States.

As every person familiar with Russia knows, the black-earth region is one of the richest and most productive in the world. It ought to be inhabited by one of the wealthiest and happiest of peoples. Yet such is not the case. According to Count Tolstoi, who contributed recently a letter to the London Times on the subject, the inhabitants are among the poorest and most miserable in the world. They are in a state of chronic starvation. They are obliged to content themselves with nearly a third less food than is sufficient to maintain normal health. The physical effect of this insufficiency of food is a decrease in vitality, a diminished stature, and a check to the growth of population. It is proved, first, by the failure of the peasants of the region to meet the requirements for military service, and, second, by the statistics of population, which show that the increase of births over deaths has fallen from the maximum reached twenty years ago to zero.

But the mental effects of the destitution wrought by the robberies of the Government are more distressing even than the physical. It gives birth to a

stolidity and despair that tend to paralyze all effort toward betterment. The people subjected to it come to feel that there is no use of making any struggle beyond the maintenance of mere existence. Whatever they get in excess of this requirement will be taken from them. "A peasant," says Tolstoi, illustrating this fact, "feels that his position as an agriculturalist is bad, but he believes that it can not be improved; and, consequently, adapting himself to this hopeless position, he no longer fights against it, but lives and acts only in so far as he is stirred by the instinct of self-preservation. Moreover, the very wretchedness of his condition increases still more his depression of spirit. The lower the economic condition of a population sinks, like a weight on a lever, the more difficult it becomes to raise it again; the peasants feel this, and, as it were, throw away the helve after the hatchet. 'Why should we trouble ourselves?' they say. 'We sha'n't get fat. If we can only keep alive.'"

The fruits of this mental state are as palpable as those of the lack of food. They are to be found in every direction. In manners, habits, and customs the peasants are hopelessly conservative. They belong, not to the nineteenth century, but to the ninth. Instead of adopting new and improved methods of agriculture, they cling to those of the subjects of Rurik. They use the old plow, distribute tillage in three crops, and divide their fields into long, narrow strips. So slowly do they toil with primitive implements and debilitated animals, and so indifferent are they to what they are doing, that it takes them a day to do the work that a well-fed and alert peasant would do in half the time. A more deplorable sign of demoralization is the prevalence of family discord and loss of interest in a higher life. The aggressions of the state have stimulated selfishness, bad temper, and incipient rebellion. The children disobey their parents, the younger brothers reject the primacy of the older, and money earned elsewhere is kept from the family treasury. With the decadence of family life there is a decadence of religious life. Although the peasants are nominally orthodox, they care nothing for religion. Even the clergy confirm the fact that they are becoming more and more indifferent to the church. What they seek is not to penetrate the mysteries of life, but to obliterate consciousness of them. "Under these circumstances," says Tolstoi, alluding to the economic and mental decadence, "the craving for forgetfulness is natural, and accordingly spirits and tobacco are being consumed in ever greater and greater quantities." He adds that "even quite young boys drink and smoke."

Since the loss of freedom due to the seizure of property is the same in the last analysis as that due to an abridgment of the right to think and act, the evils of

ecclesiastical and bureaucratic despotism do not differ from those of excessive taxation. Nevertheless, they receive separate attention at the hands of Tolstoi. As a proof of the blight of a church that the peasants have no part in directing, he points to the profound and beneficent change wrought the moment they fall in with a sect of dissenters. "Their spirits at once rise," he says, "and at the same time the foundation of their material prosperity is laid." A blight of the same kind can be traced to the attempt of the state to play the paternal rôle. "Nominally," says Tolstoi again, "there exist for the peasants special laws with regard to the possession and division of land, to inheritance, and to all the duties connected with it, but in reality there is a kind of hodge-podge of regulations, explanation, customary laws, decrees of courts of cassation, and so on, which naturally makes the peasants feel their absolute dependence on the will of innumerable officials." Knowing that they are powerless to resist the Government, which is constantly flogging them for disobedience or stupidity, they comply as best they can with the thousand rules and regulations made for them. Seldom do they think of acting upon their own responsibility. Thus they lose the power of private initiative. What the impoverishment of taxation has not done to ruin them is left to ecclesiastical and bureaucratic despotism to complete.

It is curious to note that Tolstoi's remedy for these evils is the one that Herbert Spencer himself might have suggested. With one stroke he dismisses the prescriptions that the social reformer in the United States as well as in Russia attaches so much importance to. It is not, in his opinion, "the ministry of agriculture, with all its contrivances," that will reclaim the peasants, nor is it "exhibitions nor schools for rural economy," nor that "unfailing" remedy "for all evils," i. e., parish schools. The thing they need is freedom. "It is necessary," says Tolstoi, "to give them religious liberty, to subject them to common instead of special laws—the will of rural officials; it is necessary to give them liberty of education, liberty of reading, liberty of moving about, and, above all, to remove the power to torture brutally by flogging grown-up people simply because they belong to the peasant class." But to give them such freedom means to deliver them not only from excessive taxation but from vexatious rules and regulations. It is to apply to them the same remedy that must be applied in the United States to save the American people, now so heavily taxed and so oppressed by countless laws, from the same social decadence that afflicts Russia.

THE ADVANCE OF SCIENCE.

The paper by Sir J. Norman Lockyer, which we publish in this number, recounts in an interesting manner the steps by which science gained a place for itself in the educational systems of the world. To us, in the latter years of the nineteenth century, it is apt to seem strange that the recognition of science as an essential element in all education should have come so late in the world's history; but reflection shows that it could not well have been otherwise. To view and examine any subject scientifically involves not only a deliberate and prolonged mental effort, but the holding in check of some of the most active propensities of the human mind, such as imagination and what Bagehot has called "the emotion of belief." In a certain sense imagination is the precursor of science; but, in the early stages of human development the precursor is mistaken for the true teacher. The lesson that there is no royal road to truth, nothing but a highway on which much wearisome plodding must be done, is one which human nature in general does not take to kindly. Even in the present day how many there are who chafe at the restraints which Science imposes on belief, whose disposition is to break her bonds asunder and have none of her reproof! When we think, indeed, of what the intellectual condition of the world is to-day, with the wonders which science has wrought raising their testimony on every hand, it is hardly surprising that, a couple of centuries ago, it was difficult to get any systematic provision made for the teaching of science. However, that battle has been fought and won, and Science has long since definitely entered on her career of beneficent conquest. Systems founded on imagination, or on merely abstract reasoning, come and go, wax and wane; but the empire of science once set up can never be subverted. We must hope that some day it will rule in the realm of morals as now it does in that of material things. Not till then will its perfect work be done.

Scientific Literature.

SPECIAL BOOKS.

Prof. *Dean C. Worcester*, of the University of Michigan, spent eleven months, beginning in September, 1887, in the Philippine Islands in connection with the second scientific expedition of Dr. J. B. Steere. He went there again, with an expedition of which he was chief, in July, 1890, and spent two years and eight months. His object in both expeditions was the study of birds. In the course of them he visited twenty-two islands. The first expedition was unofficial and was regarded suspiciously by the authorities of the islands; the second was armed with a special permission from the Spanish Minister of the Colonies and enjoyed every advantage. The scientific results of both were reported to the United States National Museum, and the collections were deposited in its cabinet. The general results, the story of the adventures of the members of the expedition, with their observations on the geographical features of the islands, their peoples, and the social conditions prevailing there, are given in a popular style in the volume before us.[50] The account is preceded by a short sketch of the history of the islands, as an aid to the better comprehension of their present condition and the reasons for it. Of the natives, who form the bulk of the 8,000,000 of the population of the islands, there are more than eighty distinct tribes, each with its own peculiarities, scattered over hundreds of islands. The more important of these islands may be reached by lines of mail and merchant steamers, which afford tolerably frequent communication between them. The difficulties begin when one attempts to make his way into the interior of the large and less explored of them, or desires to reach ports at which vessels do not call. Roads are scarce and to a large extent impracticable, while enemies and dangers are many, and such boats as one can find off the regular routes are precarious. As to climate, if one is well, able to live as he pleases, and most scrupulously observes all sanitary rules, keeping the most healthy spots, he may escape disease; but if he steps a little aside at any point he is in danger. It is very doubtful, in the author's judgment, if many successive generations of European or American children could be reared there. Evidences of the action of earthquakes and volcanoes are seen almost everywhere, and elevation and subsidence are going on with great rapidity at the present time. Hence it is not safe to build substantial houses in Manila. The soil is astonishingly fertile: fruits—in about fifty varieties

—are the chief luxury; the value of the forest products is enormous; the mineral wealth is great, but has never been developed. Professor Worcester speaks of five millions of civilized natives of the Philippines. They belong for the most part to three tribes: the Tagalogs, Ilocanos, and Visayans. Without drawing fine distinctions between these, they are regarded as showing sufficient homogeneity to be treated as a class. They have their bad qualities and their good, which are reviewed with an apparent inclination on the part of the author to like them, and the conclusion that, having learned something of their power, they will now be likely to take a hand in shaping their own future. There are also barbarians, of whom the Moros of Sulu are a type—bloodthirsty and faithless, and as careless of human life as one would be of weeds in a field; and savages of all degrees, down to the lowest. The government is various, according to the particular governor and the people he has to deal with, but all of the Spanish or Moro type. The clergy are the dominant class; and of these the friars or brethren of the orders exert an evil influence, while the Jesuits are believed to be a distinctive power for good. Much can be said in favor of the insurgents' demand that the friars be expelled from the colony and their places taken by secular clergymen not belonging to any order. Professor Worcester has made a very lively, interesting, and instructive book, which is marred, however, by occasional evidences that, while begun with serious purpose, it has been hurried to meet a passing demand, and by the too frequent intrusion of trivialities and slang.

We are often surprised at manifestations of individuality and intelligence in domestic animals and pets, and are accustomed to attribute extraordinary qualities to the beasts in which we perceive them; as if each animal could not have its peculiar traits and talents as well as each man. We hardly imagine that there are any special differences in wild animals, and that idiosyncrasies of character and diversities of gifts and powers of adaptation may run through the whole animal kingdom. A closer acquaintance with Nature would teach us better. Certain stories and myths of savages show that they had a fair appreciation of the individual peculiarities of animals, and farmers' boys, who live in natural surroundings, know something of these things. The subject is now presented to us in a fairly clear light by Mr. *Ernest Seton Thompson*, as illustrated in the careers of a number of typical specimens of animals and birds whose characters and acts, as they came under his observation, are related in *Wild Animals I have Known*.[51] The stories, he avers, are true; the animals in the book are all real

characters. They lived the lives he has depicted, and showed the stamp of heroism and personality more strongly by far than it has been in the power of his pen to tell. Among them was Lobo, the wolf, of the Corrumpaw Cattle Range, New Mexico, the leader of a gang, who exhibited some of the qualities of an able general, and was a beast of influence, powerful, vigilant, crafty, and the terror of the settlement; and who was only trapped when grief for the loss of a female companion deprived him of the wit by which he had escaped all previous efforts to take him. Silverspot, the crow, was the leader of a large band. He had his calls, which the other crows obeyed, and was always to be seen at the head of his company in their incursions into the fields, and guiding them in their journeys northward and southward. Raggylug, the rabbit, is acknowledged to be a composite, embodying in one the ways of several rabbits, their nesting habits and ways of concealment and devices to baffle pursuers. Bingo, the dog, had associates as well as enemies among the wolves, and different characters by day and by night. In a similar way to these, the traits of the fox, the pacing mustang, other dogs than Bingo, and the partridge are portrayed. In all the stories the real personality of the individual and his view of life are the author's theme, rather than the ways of the race in general, as viewed by a casual and hostile human eye. The moral is suggested by the lives and emphasized by Mr. Thompson, that "we and the beasts are kin. Man has nothing that the animals have not at least a vestige of; the animals have nothing that man does not at least in some degree share. Since, then, the animals are creatures with wants and feelings differing only in degree from our own, they surely have their rights." It would be hard to speak too well of the graphic expressiveness of the illustrations.

GENERAL NOTICES.

"An unscientific account of a scientific expedition" is what Mrs. Mabel Loomis Todd happily styles the story of the Amherst Eclipse Expedition, told in *Corona* and *Coronet*[52]—"Corona" being what the expedition went to see, and "Coronet" the vessel that took it to the observing station. Professor Todd was the astronomer of the party, and Mrs. Todd, who has published a work on astronomy, was his companion. She believes that certain aspects of the trip, covering as it did more than ten thousand miles of sailing for the party, and at least forty-five thousand miles of deep-sea voyaging for the Coronet, were worthy of narration. The astronomical purposes of the expedition, the objects it sought to obtain, the scientific bearings of the observations, and the methods, are intelligibly set forth in the introduction to the book. The rest is devoted mostly to narrative, the social

aspects of the voyage, and the incidents. A short sojourn was made at the Sandwich Islands, where the more interesting objects were visited. Mrs. Todd was with Kate Field when she died there, and gives an account of her last hours. A voyage of four weeks carried the party to Yokohama, whence some of the members went to the capital and other interesting points in Japan, while the rest were preparing the observing station at Esashi, eleven hundred miles north of Yokohama—"a village on the shores of the Sea of Okotsk, among the hairy Ainu," in a region so remote that the native steamers had only recently begun to go there at all. Besides the account of the observations, descriptions are given of such Japanese experiences as life in Kioto, cormorant fishing, yachting in the Inland Sea, the tidal wave, and observations among the Ainu, with a visit on the way home to an Arizona copper mine.

The late Prof. *James D. Dana* had begun a revision of his *Text-Book of Geology* a short time before his death. Prof. William North Rice was requested by his family to complete the revision, and the result is the present volume.[53] It was intended in the original plan of revision to preserve as far as possible the distinctive characteristics of the book. It was to be brought down to date as regards its facts, but was still to express the well-known opinions of its author, with the general plan of arrangement kept unchanged. It soon became evident, however, that more and greater changes than had been contemplated would be required. The zoölogical and botanical classifications would have to be modified; the theory of evolution must have more recognition than it had received, especially as Professor Dana himself had adopted some of its features before his death; and the treatment of metamorphism was believed to require considerable modification. In the present edition the bearing of various events in geological history upon the theory of evolution is pointed out in the appropriate places, and the general bearing of paleontology upon evolution is discussed in the concluding chapter. All these changes seem to be in the line of continuing the usefulness of Professor Dana's most excellent and standard work, and of keeping his name before students as that of "one of the greatest of geologists and one of the noblest of men."

A true son of Nature is Mr. *F. Schuyler Mathews*, and he shows himself at his best in his *Familiar Life in Field and Forest*.[54] "There are few things," he says, "more gratifying to the lover of Nature than these momentary glimpses of wild life which he obtains while passing through the field or forest. Wild animals do not confine themselves exclusively to the wilderness; quite frequently they venture upon the highway, and we are apt to regard the meeting of one of them

there as a rare and fortunate occurrence. The daisy and the wild rose appear in their accustomed places on the return of summer, and the song sparrow sings in the same tree he frequented the year before; but the wood-chuck, the raccoon, and the deer are not so often found exactly where we think they belong. To seek an interview with such folk is like taking a chance in a lottery; there are numerous blanks and but few prizes. But because wild life is not in constant evidence, like the wild flower, is no proof that it is uncommon. To those who keep in touch with Nature, it becomes a very familiar thing, and to live a while where the wild creatures make their homes is to cross their paths continually." Mr. Mathews is in touch with Nature. He does not exactly know where to find the wild and shy, for they do not come at call, but he can put himself where he will meet them if they come around—and "one can never tell at what moment some surprising demonstration of wild life will occur at one's very doorstep." In this book Mr. Mathews records some of his meetings, at home and in his daily walks, offering as his excuse for the record, that he has lived long enough among wild animals to "respect their rights of life, and speak a good word for them when occasion offers."

The *Short Manual of Analytical Chemistry,*[55] prepared by Mr. John Muter, follows the course of instruction given in the South London School of Pharmacy. Encouraged by the continued favor which the book has received in Great Britain, the author offers a special edition of it to American students, a concise and low-priced manual, designed to introduce them to the chief developments of analytical chemistry from the simplest operations upward. It includes many organic questions generally overlooked in initiatory books. By working through it the author claims the student may expect to become familiar with a great variety of processes, and to be in a position to use with satisfaction the more exhaustive treatises dealing with any special branch he may desire to follow. In preparing it for American students, the directions, wherever the British methods differ from the American, have been modified to agree with the latter. The processes given include the qualitative analysis, all the general operations and those relating to detection of the metals, of acid radicals and their separation, of unknown salts, of alkaloids and certain organic bodies used in medicine—with a general sketch of toxicological procedure; and in quantitative analysis, directions on weighing, measuring, and specific gravity; gravimetric analysis of metals and acids, ultimate organic analysis, special processes for the analysis of air, water, and food; analysis of drugs, urine, and calculi; and analysis of gases, polarization, spectrum analysis, etc.

The pure geometry of position is mainly distinguished, according to Professor Reye's definition,[56] from the geometry of ancient times and from analytical geometry, in that it makes no use of the idea of measurement. Nothing is said in it "about the bisection of segments of straight lines, about right angles and perpendiculars, about ratios and proportions, about the computation of areas, and just as little about trigonometric ratios and the algebraic equations of curved lines, since all these subjects of the older geometry assume measurement.... We shall be concerned as little with isosceles and equilateral triangles as with right-angled triangles; the rectangle, the regular polygon, and the circle are likewise excluded from our investigations, except in the case of these applications to metric geometry. We shall treat of the center, the axes, and the foci of so-called curves of the second order, or conic sections, only as incidental to the general theory; but, on the other hand, shall become acquainted with many properties of these curves, more general and more important than those to which most text-books upon analytical geometry are restricted." Of all the other branches of geometry, the descriptive is the most helpful in facilitating the study of the geometry of position; and perspective or central projection plays an important part in it. It stands in a certain antithetical relation to analytical geometry on account of its method, which is synthetic, and whence it is sometimes known as synthetic geometry. Since metric relations are not considered in it, its theorems and problems are very general and comprehensive. As presented in von Standt's complete work, it is regarded by the author as an excellent aid to the exercise and development of the imagination; and the important graphical methods with which Professor Culmann has enriched the science of engineering in his work on graphical statistics, being based for the most part upon it, a knowledge of it has become important for students of that science. In the present work, the outgrowth of his lectures, Professor Reye has attempted to supply the want of a text-book which shall offer to the student the necessary material in a concise form.

Prof. *Cyrus Thomas* brings the qualification which a lifetime devoted to study of the subject develops, to the preparation of an *Introduction to the Study of North American Archæology*.[57] He is known to all students in this branch as a careful, judicious investigator whose work in the field has been supplemented by valuable contributions to its literature. In this volume he presents a brief summary of the progress that has been made in the investigation of American antiquities—which has been recently great indeed, and well calls for a new synopsis. His chief object has been to present the data and arrange them so as to afford the student some means of bringing his facts and materials into harmony,

and of utilizing them. He presents the theories that have been advanced, and mentions opposing views; regarding it, he says, as important to the progress of the student to know which of the questions that arise have been answered, and which hypotheses have been eliminated from the class of possibilities. The materials for the study and the methods are first explained. The relics of ancient men and the mounds are then described as under three divisions—the Arctic, the Atlantic, and the Pacific. Local as well as regional characteristics and differences are pointed out; as in the mounds as a whole, the special class of animal mounds, the pueblos, the cliff dwellings, and the Mexican and Central American monuments, the peculiar features of each are pointed out, and their territorial limits are defined. All these various kinds of works are ascribed to substantially the same people, who are supposed to have come down from somewhere in the north or northwest (the extreme northwest Pacific coast), although the different immigrations may perhaps have arrived by various routes. The people were the present Indians or their ancestors; the time of the immigration was not extremely remote; and the "mound-building habit" is shown to have persisted and been practiced till since the advent of the Europeans.

In entitling his book *The Art of Taxidermy,*[58] the chief of the Department of Taxidermy in the American Museum of Natural History evidently intends to use the word art in the high sense of a fine art; for he speaks of the enormous strides toward perfection which it has made from the former "trade of most inartistically upholstering a skin"—stuffing it, we used to call it—and of its study having been taken up of late years by a number of men of genius and education. It is largely owing to the exertions of these men that the taxidermy of the present day is so far in advance of what it was a decade since. The proverb says that art is long, and accordingly Mr. Rowley takes for the motto of his book a sentence from Thoreau, that "into a perfect work time does not enter." To the possible objection that some of his methods seem to involve considerable time and expense, the author replies in substance that if the work is not worth this, it is hardly worth while to take it up at all. If it is a proper work, and one has the proper degree of energy and enthusiasm, let him give the specimen all the time it demands. In preparing his treatise, the author has aimed to eliminate all extraneous matter, and to give mainly the results of his own experience, coupled with that of other taxidermists with whom he has come in contact. He begins with instructions about collecting tools and materials, and casting, and treats further of the preparation of birds, of mammals, and of fish, reptiles, and crustaceans; the cleansing and mounting of skeletons, and the reproduction of foliage for groups. The appendix contains addresses of reliable firms from whom tools and

materials used in taxidermy may be purchased.

The preparation of this book on *The Storage Battery* was suggested to Mr. Treadwell[59] by his finding a lack in working on these machines of any compact data concerning their construction, and the paucity of reliable discharge curves; and he concluded that a book containing such data and curves, with rules for the handling and maintenance of cells, would be valuable to all interested in storage batteries as well as to the student and manufacturer. Among the points specially mentioned by the author are the lists of American and foreign patents given as footnotes for the various types, not complete but noticing the principal patents for each cell; the chapter on the chemistry of secondary batteries, which gives the latest and most generally accepted theory concerning the chemical reactions taking place in an accumulator, and which has been approved by Dr. Sewal Matheson; and, in the appendix, tables of data comprising figures of all the batteries, methods for the measurement of the E. M. F. and internal resistance of a storage battery; and data from which the theoretical and practical capacity of an accumulator may be determined.

The *Natural Advanced Geography*[60] is a successful application of modern methods to the teaching of this science, and presents it with the interest undiminished which really appertains to it. While in the elementary book of this, the "natural" series, the pupil starts from his own home and is introduced to the study of man in relation to his environment, in the present work the fact is developed that environment itself is the chief factor in the various activities and economies of man. One of the salient features of the presentation of the subject, marked throughout the work, and one that commands high praise, is the arrangement of the facts into such order that their correlation may be perceived and the unity of Nature recognized. The isolated, barren, curt, unrelated statements that made the study of many of the old geographies hard and tedious are conspicuously absent, and the subject, studied in orderly sequence, "unfolds itself naturally and logically, each lesson preparing the way for those which follow." The first part of the work is devoted to a study of the world as a whole. The second part, comprising about three fourths of the volume, is an application of these laws to the various countries of the globe, beginning with the United States. In the United States, for instance, a general description of the whole is given, which presents a real, comprehensive mental picture of the country; and the process is repeated, in measure according to the conditions, for the several States, so that the pupil is taught what are the factors that give the characteristics and local features to each. A like method is pursued, on a more general scale,

with other countries. The colored maps are drawn on a system of uniform scales, with reliefs plainly shown according to the accepted conventions; graphic charts or sketch maps showing the distribution of products and resources are employed; and pedagogical exercises and aids are afforded abundantly.

A text-book on the *Differential and Integral Calculus*,[61] for students who have a working knowledge of elementary geometry, algebra, trigonometry, and analytical geometry, by Prof. *P. A. Lambert*, has the threefold object of inspiring confidence, by a logical presentation of principles, in the methods of infinitesimal analysis; of aiding, through numerous problems, in acquiring facility in the use of these methods; and, by applications to problems in physics, engineering, and other branches of mathematics, to show the practical value of the calculus. By a division of the matter according to classes of functions, it is made possible to introduce these applications from the start, and thereby to arouse the interest of the student. By simultaneous treatment of differentiation and integration and the use of trigonometric substitution to simplify integration it is sought to economize the time and effort of the student.

The Birds of Indiana, by *Amos W. Butler*, lately published as part of Willis S. Blatchley's Twenty-second Annual Report on the Geology and Natural Resources of Indiana, is just at hand. It is one of the most accurate, detailed, and satisfactory local catalogues yet published. Three hundred and twenty-one species of birds have been taken in Indiana, and of each of these is given a detailed description, with a general account of its habits, song, migration, and nesting. In the case of the more rare species, full records of the dates and places of capture of the known specimens are appended. Analytical keys to genera and species are also given, so that every facility is furnished for the identification of species. This book is a model of its kind, and is a worthy fruit of Mr. Butler's twenty years of devoted study of the birds of his native State.

Robert H. Whitten, in his monograph on *Public Administration in Massachusetts*—the relation of central to local activity—pursues a parallel course with that taken by Mr. John A. Fairlie in a similar essay on the Centralization of Administration in New York State, of this same series of Columbia University studies in History, Economics, and Public Law. Having found the systems and tendencies of administration in the early settlement of Massachusetts all for expansion and decentralization, Mr. Whitten now perceives the course altogether changed, and centralization more and more the rule. The change corresponds with changes in the conditions of life, and keeps track with them step by step. Of great dynamic forces which have been set to work and are bringing about a

complete reconstruction of the social structure, improvements in transportation and communication were the most vital—first, turnpikes, then the steamboat, railroad, and telegraph; then the horse railway, cheap postage, the telephone, the electric railway, and the bicycle. The tendency at first was to bring about a concentration which was attended by the congestion of population in cities and the depopulation of the rural towns. "The electric railway, the telephone, and the bicycle came in to counteract these evils; while their tendency is strongly toward the centralization of bureaus, it is also toward the diffusion of habitations. These great socializing forces, going hand in hand with the development of the factory system and improvement of machinery, make possible a vastly higher organization of society than was possible under a stagecoach *régime*."

The first volume of the Final Report of the State Geologist of New Jersey, on Topography, Magnetism, and Climate, was published in 1888. Other volumes embracing other topics have been published since, and in the meantime the supply of the first volume has been exhausted, while the demand has continued. It has been therefore necessary either to reprint the volume or to publish a new work which should include the important statistical matter of it. Accordingly, we have now *The Physical Geography of New Jersey*, prepared by Prof. *Rollin D. Salisbury*, with an appendix embodying "Data pertaining to the Physical Geology of the State," by Mr. C. C. Vermeule, who was formerly in charge of the topographic survey, and is author of the volume on water supply. The two parts of the volume treat of the topography of New Jersey as it now is, and the geological history of the topography. The report is accompanied by a relief map of the State, prepared by Mr. Vermeule on the basis of the topographical survey, and presenting, therefore, an accurate picture of the relief. It shows the great features of the State, its ranges of mountains, hills, tablelands, plains, marsh lands, streams, and water areas in their proper relations to one another; and it is contemplated to put it in every schoolhouse in the State as an aid in the study of geography.

M. *Imbert de Saint-Amand's* series of books about the Second French Empire furnish very interesting reading, are, so far as our recollection of events goes, historically accurate, and fill a gap which the literary world always has to suffer concerning any period too recently passed for a competent judicial mind to have appeared to tell its story. The second of the series—*Napoleon III and his Court*—takes Louis Napoleon at the height of his success and happiness, just after he had married the beautiful Eugénie, of whom the world has nothing harsh to say, and carries him through the period of his wonderful popularity and brilliant

accomplishments to the close of the Crimean War and the birth of the prince whose fate was so unhappy. It deals, in a pleasant manner, and all favorable to Napoleon, but not adulatory, with affairs social, political, and military, in which it is hard to say whether the tact or the good fortune of the subject of the history shone most brilliantly. We are told how Eugénie won the French nation; of Napoleon's good will, especially manifested toward all that could contribute to his exaltation; of his dealings with the sovereigns around him, gradually winning their recognition, including that of Nicholas of Russia; of the darkening of the clouds of war, the Crimean campaigns; of the interchanges of courtesies, gradually rising into close, firm friendship, with the British court; and of the birth of the Prince Imperial. Think what we may of the character of the reign of Louis Napoleon and of its influence, it marked an epoch in nearly every line of development of the world's history, and was as distinctly separated from what came before it and from what followed it as if a broad line were drawn around it; and it left some important results that are not likely to be soon effaced. M. de Saint-Amand writes from personal knowledge, having witnessed or participated in much of what he describes, and has in Elizabeth Gilbert Martin a fully competent and acceptable translator. (Published by Charles Scribner's Sons. Pp. 407. Price, $1.50.)

The paper of the late Dr. *Theodor Eimer* on *Orthogenesis and the Impotence of Natural Selection in Species Formation* is published by the Open Court Company, Chicago, as No. 29 of their Religion of Science Library. Pp. 56. Price, 25 cents.

The second volume of Uncle Robert's Geography, of Appletons' Home-Reading Series—*On a Farm*—Mr. *Francis W. Parker*, the editor, and *Nellie Lathrop Helm*, emphasizes the importance of parents and teachers, giving full and complete recognition of the immense educational value of spontaneous activities as displayed in motive and interest; a recognition which "should be followed by active encouragement and direction of the child's play, work, and observations." The story deals entirely with the interests and life of children in the environment of the country. A little girl is in her playhouse in a Virginia fence corner, with her doll and mimic housekeeping. Her shy, retiring companions are the birds who peep into the playhouse, and, after she has gone away, come into it and pick up the crumbs she has left. This leads to talks about different birds and their nest building. A St. Bernard dog is introduced and furnishes the opportunity for bringing in stories of the Alps, their glaciers and snows, and the Hospice of St. Bernard, and then about other dogs. Susy makes a garden in the woods, and the

wild flowers become the subjects of her spontaneous study. So with the rabbits, bread making and the grain that furnishes the material for the bread, and other incidents; with more birds' nests; the nature of bulbs, squirrels, etc.; and finally Uncle Robert sets the child to finding out how the animals in the woods spend the winter, and whether they are doing anything now in preparation for it. (New York: D. Appleton and Company. Price, 42 cents.)

The *Thirty-fifth Annual Report* of the Secretary of the State Board of Agriculture of Michigan includes the Ninth Annual Report of the Agricultural College Experiment Station, and is largely taken up with the work of the latter institution, reviewing the records of the college departments and presenting the reports and bulletins of the station. The record of meteorological observations, the Proceedings of the Farmers' Institutes, the Transactions of the Association of Breeders of Improved Live Stock, and the Transactions of the State Agricultural Society are also incorporated in the volume. An interesting feature of the publication is the insertion of a portrait and biographical notice of one of the pioneer farmers of the State, Enos Goodrich, who was also prominent in public life.

The translation by *Eleanor Marx Aveling* of Lissagaray's *History of the Commune of 1871* was made many years ago at the request of the author from a contemplated second edition which the French Government would not allow published. The work having been revised and corrected by the translator's father, and for other reasons, no changes have been made to adapt it to the time of its issue from the press. The translator claims that Lissagaray's work is the only reliable and accurate history that has yet been written of the Commune. He has not attempted, she says, to hide the errors of his party, or to gloss over the fatal weakness of the revolution. Of course, a very different view of the movement is given from that presented in the French accounts, as well as that generally held by English and Americans; but the communists have a right to be represented and heard, and it is well that they have so competent a spokesman. (Published by the International Publishing Company, 23 Duane Street, New York.)

PUBLICATIONS RECEIVED.

Academy of Natural Sciences of Philadelphia. Proceedings, 1898. Part II. April to September. Pp. 224, with plates.

Agricultural Experiment Stations. Bulletins and Reports. Cornell University: No. 152. Studies in Milk Secretion. By H. H. Wing and Leroy Anderson. Pp. 56; No.

153. Impressions of our Fruit-growing Industries. By L. H. Bailey. Pp. 18.—Iowa State College of Agriculture, etc.: No. 10. Anatomical and Histological Studies. Pp. 25, with plates.—New Hampshire College: No. 53. The Farm Water Supply. By Fred W. Morse. Pp. 12; The Winter Food of the Chickadee. By Clarence M. Weed. Pp. 16.—United States Department of Agriculture: The Chinch Bug. By F. M. Webster. Pp. 82; Some Books on Agriculture and Sciences related to Agriculture published in 1896-'98. Pp. 45; Forage Plants and Forage Resources of the Gulf States. By S. M. Tracy. Pp. 55; List of Publications relating to Forestry in the Department Library. Pp. 93.—University of Illinois: The Chemistry of the Corn Kernel. By C. G. Hopkins. Pp. 52.

Austin, Herbert Ernest. Observation Blanks for Beginners in Mineralogy. Boston: D. C. Heath & Co. Pp. 80. 50 cents.

Bailey, M. A. American Elementary Arithmetic. American Book Company. Pp. 205.

Beddard, Frank E. The Structure and Classification of Birds. New York and London: Longmans, Green & Co. Pp. 548.

Barnes's National Vertical Penmanship. Nos. A and B, and 1 to 6. American Book Company.

Bookseller, The, Newsdealer, and Stationer. Semimonthly. New York: 156 Fifth Avenue. Pp. 38. $1 a year.

Boutwell, Hon. George S. Problems raised by the War. Boston: Woman's Educational and Industrial Union. Pp. 20.

Bulletins, Reports, Proceedings, etc. Michigan Monthly Bulletin of Vital Statistics, October, 1898. Pp. 16.—National Pure Food and Drug Congress: Journal of Proceedings, March, 1898. Pp. 53.—United States Department of Labor: Bulletin No. 18, September, 1898. Pp. 124; No. 19, November, 1898. Pp. 42.

Card, Fred W. Bush Fruits. A Horticultural Monograph of Raspberries, Blackberries, etc. New York: The Macmillan Company. Pp. 537. $1.50.

Carpenter, Frank G. Carpenter's Geographical Reader, North America. American Book Company. Pp. 352.

Clark, William J. Commercial Cuba, with an Introduction by E. Sherman Gould.

New York: Charles Scribner's Sons. Pp. 514 with maps. $4.

Collyer, Rev. Robert. The Parable of "Lot's Wife." Pp. 13. 5 cents.

Earl, Alfred. The Living Organism. An Introduction to the Principles of Biology. New York: The Macmillan Company. Pp. 271. $1.75.

Fisher, George E., and Schwatt, Isaac J. Text-Book of Algebra, with Exercises. Philadelphia: Fisher & Schwatt. Pp. 683. $1.75.

Hall, Fred S. Sympathetic Strikes and Sympathetic Lockouts. Columbia University. (Studies in History, Economics, and Public Law) Pp. 118.

Hill, Frank A. How far the Public High School is a Just Charge on the Public Treasury. Pp. 36.

Holman, Silas W. Matter, Energy, Force, and Work. New York: The Macmillan Company. Pp. 257. $2.

Hornbrook, A. R. Primary Arithmetic. American Book Company. Pp. 253.

Geikie, James. Rock Sculpture, or the Origin of Land Forms. New York: G. P. Putnam's Sons. Pp. 397. $2.

Hurley, Denis M. The Metric System of Weights and Measures in the Congress of the United States. Pp. 4.

Inglis, George E., Editor. The Anglo-Saxon Monthly. Chicago: The Anglo-Saxon Publishing Company. 10 cents. $1 a year.

Jackman, Wilbur S. Nature Study for Grammar Grades. Danville, Ill.: Illinois Printing Company. Pp. 407.

Jenkins, C. Francis. Animated Pictures. Washington, D. C.: C. Francis Jenkins. Pp. 118.

Jordan, David Starr. Footnotes to Evolution. New York: D. Appleton and Company. Pp. 392. $1.50.

Lassalle, Ferdinand. The Workingman's Programme. New York: International Publishing Company. Pp. 62.

Macmillan Company, The. Catalogue of Books, Section VII, Scientific, pp. 24; and Section IX, Classical and Educational, pp. 26.

Makato, Tentearo. Japanese Notions of European Political Economy. Philadelphia. Pp. 42.

Marshall, Henry Rutgers. Instinct and Reason. New York: The Macmillan Company. Pp. 575. $3.50.

Merriman, Mansfield. Elements of Sanitary Engineering. New York: John Wiley & Sons. Pp. 216.

Metric System, The, of Weights and Measures. Hartford, Conn.: Hartford Steam Boiler Inspection and Insurance Company. Pp. 196.

Millennial Dawn, Vol. IV. The Day Of Vengeance. Allegheny, Pa.: The Tower Publishing Company. Pp. 668. 35 cents.

Park. J. G. Language Lessons. American Book Company. Pp. 144.

Payne, Frank Owen. Geographical Nature Studies. American Book Company. Pp. 144. 25 cents.

Peabody, J. E. Laboratory Exercises in Anatomy and Physiology. New York: Henry Holt & Co. Pp. 79. 60 cents.

Preece, W. H. President's Address before the Institution of Civil Engineers, November 1, 1898. Pp. 29.

Reprints. Coulter, John M. The Origin of Gymnosperms and the Seed Habit. (Botanical Society of America.) Pp. 16.—Brinton, Daniel G. The Peoples of the Philippines. Pp. 16.—Eckles, C. H. The Relation of Certain Bacteria to the Production of Butter. Pp. 10.—Graziani, Dr. Giovanni. A Sensitive Test for Kryofine in the Urine, etc. Pp. 81.—Keen, W. W. The Advantages of a Permanent Abdominal Anus, etc., in Operations for Cancer of the Rectum. Pp. 11; The Advantages of the Trendelenburg Posture during Operations involving the Cavities of the Mouth, etc. Pp. 7; Removal of Angioma of the Liver, etc. Pp. 12.—Keen, W. W., and Spiller, W. G. On Resection of the Gasserian Ganglion, etc. Pp. 38, with plates.—Ladd, E. F. The Proteids of Cream. Pp. 3; and Humates and Soil Fertility. Pp. 7.—Lloyd, James Hendrie. A Study of the Lesions in a Case of Trauma of the Cervical Region of the Spinal Cord simulating Syringomyelia. Pp. 18.—Sherwood, W. L. The Frogs and Toads found in the Vicinity of New York City. Pp. 27.—Tromsdorff, Richard. Observations at the Clinic of Professor Ebstein on Kryofine. Pp. 12.

Ripley, Frederic H., and Tappen, Thomas. A Short Course in Music. Book Two. American Book Company. Pp. 175.

Russell, Israel C. Rivers of North America. New York: G. P. Putnam's Sons. Pp. 327. $2.

Sands, Maniel. Opposites in Religion. New York: Peter Eckler. (Library of Liberal Classics, Monthly). Pp. 138. 50 cents.

Savage, M. J. The Word of God: The Evils of Religious and Political Pessimism. Boston: George H. Ellis. Pp. 18 each.

Schimmel & Co., Leipzig and New York Semiannual Report (fine chemicals), October, 1898. Pp. 64, with map.

Seymour, A. T., Editor. The Science Teacher. Monthly. Orange, N. J. Pp. 12. 15 cents. $1 a year.

Smithsonian Institution and United States National Museum. Annual Report of the Board of Regents to July, 1896. Pp. 727.—Bean, Barton A. Notes on a Collection of Fishes from Mexico, etc. Pp. 4.—Cook, O. F. American Oniscoid Diploda, etc. Pp. 16, with plates.—Coquillet, D. W. Report on Japanese Diptera. Pp. 36.—Enkle, Arthur. Topaz Crystals in the Mineral Collection of the Museum. Pp. 10.—Gilbert, C. N. Caulolepis Longidens, Gill, on the Coast of California. P. 1.—Jordan, David Starr, and Evermann, Barton D. The Fishes of North and Middle America. Part III. Pp. 978.—Marlatt, C. L. Japanese Hymenoptera of the Family Teuthredonidæ. Pp. 16.—Mearns, Edgar A. Mammals of the Catskill Mountains. Pp. 20.—Moore, J. Percy. The Leeches of the United States National Museum. Pp. 20, with plates.—Oberholser, Harry C. Revision of the Wrens of the Genus Thryomanes, Sclater. Pp. 30.—Rathbun, Mary J. Brachyura Collected by the Steamer Albatross between Norfolk, Va., and San Francisco. Pp. 50, with plate; and Fresh-Water Crabs of America. Pp. 30.—Smith, Hugh M. Amphiura, or the Congo Snake, in Virginia. P. 1.—Smith, John B., and Dyar, Harrison G. The Lepidopterous Family Noctuidæ of Boreal North America, etc. Pp. 194, with plates.—Starks, Edwin C. Osteology and Relationships of the Family Zeidæ. Pp. 8, with plates.—Stearns, Robert E. C. A Species of Actæon from the Quaternary Deposits of Spanish Height, San Diego, Cal. Pp. 3; and Cythera (Tivala) Crassateloides, Conrad, etc. Pp. 8, with plate.—Stejneger, Leonhard. A New Species of Spiny-tailed Iguana from California. P. 1.—Test, Frederick C. Variations of the Tree Frog, Hyla Regilla. Pp. 16, with plate.—True, Frederick W. Nomenclature of the Whalebone Whales, etc. Pp. 20.

—Walcott, C. D. Cambrian Brachiopoda, Obolus, and Singulella, etc. Pp. 36.

Sue, Eugène. The Silver Cross, or the Carpenter of Nazareth. New York: International Publishing Company. Pp. 151.

Sullivan, Christine Gordon. Elements of Perspective. American Book Company. Pp. 96.

Terrestrial Magnetism. An International Quarterly Journal. L. A. Bauer and Thomas French, Jr., Editors. University of Cincinnati. Pp. 46, with plates. 60 cents. $2 a year.

Vines, Sidney H. An Elementary Text-Book of Botany. New York: The Macmillan Company. Pp. 611. $2.25.

Volta Bureau, Washington, Publications of Catalogue of Books by Prof. A. Melville Bell.—Some Differences in the Education of the Deaf and the Hearing. Pp. 15.—International Reports of Schools for the Deaf. Pp. 27.—Bell, A. G. Methods of Instructing the Deaf in the United States. Pp. 4.—Gordon, J. C. The Difference between the Two Systems of Teaching Deaf-mutes the English Language. Pp. 4.—Gilman, Arthur. Miss Helen Adams Keller's First Year of College Preparatory Work. Pp. 14.—Bell, Mabel Gardiner. The Story of the Rise of the Oral Method in America as told in the Writings of the Hon. Gardiner G. Hubbard. Pp. 50.

Voorhees, Edward B. Fertilizers. New York: The Macmillan Company. Pp. 335. $1.

Wadden Turner, Susan, Prof. William, and Jane. In Memoriam. By Caroline H. Dall. Pp. 19.

Weysse, Arthur W. An Epitome of Human Histology. New York: Longmans, Green & Co. Pp. 90. $1.50.

Fragments of Science.

The Huxley Lecture.—The Charing Cross Medical School in London, which had the good fortune some fifty-three years ago to number Huxley among its pupils, had largely through this fact the honor of being addressed on October 3d by Professor Virchow, the greatest living pathologist and one of the greatest of living scientists. There was a peculiar fitness in his delivering the Huxley lecture, for, while Professor Virchow's work has been chiefly that of the specialist, his co-operation with laborers in other fields, his continued efforts to popularize science, and the prominent position which he has occupied for the last thirty years in public life, have given him a standing in Germany somewhat akin to that of Huxley in England. His career is a striking illustration, as was also Huxley's, of the happy results to humanity from a combination in one man of great ability as an investigator with a facility for generalization and the practical application of scientific truths to the concrete problems of science and civilization. Professor Virchow is described as modest and unassuming, and very much of a contrast in all ways to the ordinary German professor. His address was on The Recent Advances in Science, and their Bearing on Medicine and Surgery. It was inevitable that he should refer to Huxley, of whom he was in some sense a pupil. In speaking of the rapid growth of the latter during his four years on the Beagle, he said: "How this was possible any one will readily understand who knows from his own experience how great is the value of personal observation.... Freed from the formalism of the schools, thrown upon his own intellect, compelled to test each single object as regards properties and history, we soon forget the dogmas of the prevailing system, and become first a skeptic and then an investigator." This paragraph is especially worthy of notice, because it points out one of the invariable characteristics of the great man. In whatever field his greatness may lie, he will be found to have broken away from the formalism and conservatism of the schools, and that his great work is based on personal observation and research. This was notably the case with Professor Virchow's establishment of the cellular pathology, as well as of Huxley's researches in comparative anatomy. Our present school system is lamentably weak in this particular, tending to stifle rather than stimulate originality and self-dependence. Professor Virchow's address was, of course, interesting and instructive, but, as he said, much too short for anything like an adequate treatment of the subject. The chief interest of the occasion lay in its associations. An address by Rudolph

Virchow, at a meeting presided over by Lord Lister on an occasion commemorating Professor Huxley, left only one thing to be desired—the presence of the latter. For a biologist, or in fact a modern scientist of any description, one can not imagine a more delightful occasion.

The Climate of Cuba.—Systematic records of weather appear to be wanting in Cuba. The meteorological observations kept up for several years by Andre Poey are not accessible, no need of their being published having been found. The chief source of information on the subject is the observations which have been kept up at Belen College, Havana, since 1859. From these and a few scattered observations of brief periods at other towns, and by comparison with notes taken at other West Indian stations, W. F. B. Phillips, of the United States Department of Agriculture, has attempted to describe the climate of Cuba. The average annual temperature of the past ten years at Havana was 77° F., and the difference between the highest and the lowest yearly means was only 1.1° F. The warmest month is July, with an average temperature of 82.7° F., and the coldest is January, with an average temperature of 70.3° F. The highest temperature recorded was 100.6° F., in July, 1891, and the lowest 49.6°. Brief intermittent records at Matanzas, more than sixty years old, give a mean annual temperature of about 78°, with 93° as the highest and 51° as the lowest. At Santiago the annual mean appears to be about 80°, and the difference between the warmest and coldest months about 6° F. Records of temperature in the interior, such as they are, give annual means of from 73.6° to 75°, apparently showing lower temperatures than on the coast. The average daily range of temperature is about 10°, the highest occurring between noon and two o'clock P. M., while sudden variations in the temperature of the day are not unknown. The average yearly rainfall at Havana is about fifty-two inches. The season of heavy rainfall begins in the latter part of May and first of June, and lasts till October, and during this period about sixty-three per cent of the year's rain is precipitated. Rain occurs on about one day in three, in heavy downpours of short duration. Notwithstanding the frequency of rain during the summer months, these do not present the greatest number of cloudy days. The days on which rain does not fall are usually perfectly cloudless, and, in general, no clouds are seen in summer except while the showers are falling; while in other months cloudy days sometimes occur without rain. The average velocity of the wind is about 7.5 miles an hour, with variations, according to the season, from 8.5 miles in winter to 6.5 miles in summer. The diurnal variation in wind velocity is much more pronounced than the seasonal variation.

The New Planet D Q.—The number of minor planets discovered during the last few years, and their lack of practical importance in astronomy, has tended to distract astronomers' attention from the search for them, as unprofitable, and the announcement of a new one attracts little attention, as a rule. The planet D Q, however, discovered by Herr Witt, of the Urania Observatory, of Berlin, on August 13th last, has aroused from the first special attention through its remarkable behavior. The orbit is a very unusual one. Mars has always been considered our nearest neighbor, although it was known that some of the minor planets were slightly nearer to the sun when at perihelion than Mars is when at aphelion. But the mean distances of the latter were in all cases much greater than that of Mars; while that found for the new planet is only 1.46 as compared with 1.52 for Mars, and, as the eccentricity amounts to 0.23, the perihelion distance is only 1.13, and the least distance from the earth's orbit only 0.15 as compared with 0.27 for Venus in transit, and 0.38 for Mars in perihelion. The planet will thus be far closer to us than any other member of the solar system, and will afford a most excellent means of determining the sun's parallax. Its diameter is thought to be about seventeen miles.

Extra-Organic Factors of Evolution.—Observing that our civilization has made advances or "strides" in recent years out of all proportion to any improvements that have taken place in our organic faculties, Arthur Allin has insisted, in Science, on the importance of extra-organic factors in human development. Our sense and motor organs, he says, are essentially instruments and tools, and so is the brain; and most if not all of the three hundred or more mechanical movements known in the arts are found exemplified in the human body. Our sense organs are thus indefinitely multiplied and extended by such extra-organic sense organs as the microscope, telescope, resonator, telephone, telegraph, thermometer, etc. Our motor organs are multiplied by such agencies as steam and electrical machines, etc., in the same manner. "The printing press is an extra-organic memory far more lasting and durable than the plastic but fickle brain. Fire provides man with a second digestive apparatus by means of which hard and stringy roots and other materials for food are rendered digestible and poisonous roots and herbs innocuous. Tools, traps, weapons, etc., are but extensions of bodily contrivances. Clothing, unlike the fur or layer of blubber of the lower animals, becomes a part of the organism at will. One finds himself more or less independent of seasons, climates, and geographical restrictions." By organic heredity or the transmission of the congenital characteristics of the parents to the children, working alone, all progress depends upon the transmission of variations occurring within the organism. "Moreover, these

advantageous organic variations die with the individual, and must be born again, so to speak, with each new individual." This requires time, and progress depending on it would be indefinitely protracted. On the other hand, by means of social heredity, each new member of the race has handed to him at birth the accumulated organic advantageous variations of sense and motor organs, and the extra-organic adaptations that have multiplied so indefinitely in the age of civilized man. "The vast importance of accumulation of capital is obvious."

Fossils as criterions of Geological Ages.—Prof. O. C. Marsh said in a paper on The Comparative Value of Different Kinds of Fossils in determining Geological Age, which was read at the meeting of the British Association, that the value of all fossils as evidence of geological age depends mainly upon their degree of specialization. In invertebrates, for example, a lingula from the Cambrian has reached a definite point of development from some earlier ancestor. One from the Silurian or Devonian, or even a later formation, shows, however, little advance. Even recent forms of the same or an allied genus have no distinctive characters sufficiently important to mark geological horizons. With ammonites the case is entirely different. From the earliest appearance of the family the members were constantly changing. The trilobites show a group of invertebrates ever subject to modification, from the earliest known forms in the Cambrian to the last survivors in the Permian. They are thus especially fitted to aid the geologist, as each has distinctive features and an abiding place of its own in geological time. In the fresh-water forms of mollusca—the Unios, for example—there is little evidence of change from the palæozoic forms to those still living, and we can therefore expect little assistance from them in noticing the succeeding periods during their life history. The same law as to specialization holds good among the fossil vertebrates.

Pedigree Photographs.—Sir Francis Galton unfolded before the British Association a plan for the systematic collection of photographs of pedigree stock, particularly of cattle breeds, and of more information about them than is now obtainable. He believes that a system of this sort would greatly facilitate the study of heredity. The author had previously shown how the general knowledge that offspring can inherit peculiarities from their ancestry as well as from their parents was superseded by a general law the nature of which was first suggested to him by theoretical considerations, and this ancestral law proves the importance of a much more comprehensive system of records than now exists. The breeder should be able to compare the records of all the near ancestry of the animals he proposes to mate in respect to the qualities in which he is interested.

No present source for such information is comparable with what the system proposed would furnish. A habitual study of the form of each pure-bred animal in connection with the portraits of all its nearest ancestry would test current opinions and decide between conflicting ones, and could not fail to suggest new ideas. Likenesses would be traced to prepotent ancestors, and the amount of their several prepotencies would be defined; forms and features that supplement one another or "nick in," and others that clash or combine awkwardly, would be observed and recorded; and conclusions based on incomplete and inaccurate memories of ancestry would give way to others founded on more exact data. The value of the ancestral law would be adequately tested, and it would be possible to amend it when required.

English Names for Plants.—In the Proceedings of the Torrey Botanical Club, published in its journal for July, Dr. V. Havard suggested some principles which it would be well to follow in applying English names to plants, predicating that an authorized vernacular binomial should be assigned to each plant, so that ambiguity and confusion may be avoided. In the absence of suitable English names already recognized, it seems best to adopt the Latin genus name, if short and easy, like *Cicuta*, *Parnassia*, *Hibiscus*, or a close translation thereof, when possible, like astragal, chenopody, cardamin, while the specific English name should be an equivalent of the Latin one or a descriptive adjective. In case of all English binomials clearly applying to well-known individual species and no others, all substantives are capitalized without a hyphen, as in Witch Hazel, May Apple, and Dutchman's Pipe. In all genera in which two or more species must be designated, the genus name is compounded into one word without a hyphen, as Peppergrass, Sweetbrier, Goldenrod, Hedgenettle, etc.; except in long names, where the eye requires the hyphen, as Prairie-clover, Forget-me-not. Genus names in the possessive case (St. John's-wort) are written with the hyphen, followed by a lower-case initial. Plants commemorating individual men (Douglas Spruce, Coulter Pine) are written without the mark of the possessive. In specific names participial endings are suppressed, the participle becoming a substantive, which is added as a suffix without the hyphen; thus Heartleaved Willow is changed to Heartleaf Willow. In the discussion that followed this paper, President Addison Brown and Dr. T. F. Allen deprecated the manufacture of book names. The secretary defended the use of vernacular names, saying that they deserved more attention, and adding that in their absence the generic name should be used unchanged. Many Latin names, as *Portulacca*, win their way without change as soon as they are fairly made familiar. "Coined names seldom live. A name to be successful must be a growth, as language is."

Cooking Schools in Philadelphia.—The establishment of schools in Philadelphia for the teaching of cookery is mentioned, in the Annual Report of the Superintendent of Public Schools in that city, among the results of the general movement for manual training, as a means of mental development and practical knowledge. The teaching was introduced experimentally into the Girls' Normal School in 1887, and was in the following year made a regular branch of the course. It was later extended to other schools. There are now eight school kitchens under the department of Public Instruction, situated in different parts of the city. The question of the proper place for cookery in the school course has been solved, for Philadelphia, by putting it in the sixth school year, when the pupils are firmly established in the work of the grammar grades, and their attention has not yet been directed to preparation for admission to the High School. The course provides between twenty-five and thirty lessons, and is completed in a single year. It includes instruction in the care of the kitchen, and of the stove or range, general lessons in the classification and nutritive values of foods, the cooking of vegetables, breakfast cereals, bread, eggs, soups, meats, simple cakes and desserts, lessons in invalid cookery, and in table setting and serving. Special attention is given to the preparation of nutritious and savory dishes from inexpensive materials. About two thousand pupils, or less than one half of the number of girls of the sixth year now in the schools, are accommodated in the eight cookery schools. The pupils manifest an intelligent interest in the instruction, and spend the half day per week in the school kitchen without any appreciable loss in the other branches of study. "It comes as a period of relaxation."

A Trait Common to us All.—The doctrine of the tendency of mankind to develop the like fancies and ideas at the like stage of intellectual infancy was mentioned by Mr. E. W. Brabrook in his presidential address before the Anthropological Section of the British Association, as a generalization for which we are fast accumulating material in folklore. It is akin to the generalization that individual savage races present in their intellectual development a marked analogy to the condition of the earlier races of mankind. The fancies and ideas of the child resemble closely the fancies and ideas of the savage and the fancies and ideas of primitive man. Mrs. Gomme has found that a great number of children's games consist of dramatic representations of marriage by capture and marriage by purchase, and that the idea of exogamy is distinctly embodied in them. There can be little doubt that they go back to a high antiquity, and there is much probability that they are founded upon customs actually existing, or just passing

away, at the time they were first played. Upon the same principle, if we view children's stories in their wealth of details, we shall deem it impossible that they could have been disseminated over the world otherwise than by actual contact of the several peoples with each other. But if we view them in their simplicity of idea, we shall be more apt to think that the mind of man naturally produces the same result under like circumstances, and that it is not necessary to postulate any communication between the peoples to account for their identity. It does not surprise us that the same complicated physical operations should be performed by far-distant peoples without any communication with each other; why should it be surprising that mental operations, not nearly so complex, should be produced in the same order by different peoples without any such communication?

The Toes in Walking.—An instructive discussion of the walking value of the lesser toes by Dr. Heather Bigg is given in a recent copy of the London Lancet. Dr. Bigg believes that the lesser toes of the human foot are of little importance in walking—the great toe constituting the important tread of the foot—and in proof of this he gives an account of a patient, all of whose lesser toes it was found necessary to amputate because of persistent contraction of the tendons. On November 10, 1894, the toes were removed, especial care being taken to keep the resulting scars well up on the dorsal aspect of the foot, so as to be well away from the subsequent tread. In three weeks the patient could stand on her feet, and, after her return home, sent the following record of her progress toward complete recovery: December 30, 1894: "I am able to walk perfectly on my feet with little or no pain, but can not yet wear either slippers or boots, as they are still tender."—January 15, 1895: "I managed to get on my slippers yesterday and wore them with ease for more than six hours."—January 28th: "I put on my boots to-day for the first time. It still pains me slightly to walk; otherwise my feet are going on all right."—February 18th: "I ought to say that the steel plates only half way answer splendidly."—March 24th: "You will be glad to hear that I can walk splendidly now, just like a proper human being; it is just eighteen weeks next Tuesday since the operation."—May 5th: "I have decided to come to town next Monday week to let you see how well I can walk."—June 17th: "I played two sets of tennis on Saturday, and my feet were none the worse afterward."—July 24th: "You will be surprised to hear that the big toes have lengthened half an inch since the operation, and I have had all my boots lengthened and the toe line made straighter."—August 30th: "I know that you will be interested to hear that I have just accepted an invitation to a dance on September 13th. Whether I shall dance comfortably or not is another thing."—September 14th: "I went to the dance on Tuesday evening and thoroughly

enjoyed myself after not dancing for so long. My feet were on their best behavior, and did not pain me once during the evening. I never realized before that I had no toes until I began to dance; then it seemed so odd only to have one toe, but I suffered no inconvenience whatever from the loss of them."—December 5th: "I get on so well with my bicycle." Only two disadvantages showed themselves as the result of the operation and these were temporary. One was that the great toes tended to pervert themselves toward the middle line of the feet, a thing which was readily remedied by the use of single-toed stockings, and by packing the space in the boot left vacant by the missing toes with cotton wool; the other was a loss of local sense on the outer sides of the feet, which went to show that the lesser toes were missed rather as tactile organs than anything else. This failure of feeling righted itself in time, presumably by a vicarious and intenser sense being acquired by the skin of the outer side of the foot. In all other respects the loss of the toes discovered no inconvenience.

Animals' Bites.—That there is something more serious than the mere wound in the bite even of a healthy animal is attested by Mr. Pagin Thornton, from a chapter in his own experience, and in the testimony of a number of his own friends who have suffered for weeks together from having been bitten. "And what is more surprising to me," he says, "is that some of us may have hands crippled for some time from bites of a man's teeth." Dog bites are always dangerous, but largely from the size of the wound which a dog biting in earnest will inflict. With men they usually fail to do their best. Animals recover from wounds more easily than men do; but Lord Ebrington says that deer bitten by the dogs in Exmoor hardly ever recover. Much of the poisoning caused by bites is supposed to be due to the state of the animal's teeth; and in this way the bite of a herbivorous animal, whose teeth are usually soiled, may cause worse after effects than that of a carnivore, whose wet mouth and wet tongue keep its teeth fairly clean. A similar difference is observable in the effects of being clawed and bitten by carnivora. Wounds made by the claws of leopards are poisonous, while those caused by the teeth are rarely septic. The force with which a bite in earnest is inflicted is an important element in its dangerous character. "It seems," says the London Spectator, "as if for the moment the animal threw all its force into the combination of muscular action which we call a 'bite.' In most cases the mere shock of impact, as the beast hurls itself on its enemy, is entirely demoralizing, or inflicts physical injury. A muzzled mastiff will hurl a man to the ground in the effort to fasten its teeth in his throat or shoulder. Then, the driving and crushing force of the jaw muscles is astonishing." Sir Samuel Baker noticed that the tiger usually seized an Indian native by the shoulder, and with one jaw on one side

and the other on the other bit clean through chest and back. In nearly all cases the bite penetrates to the lungs. This kind of wound is characteristic of the bites of the *felidæ*. Hardly any bird recovers from a cat's bite, for the same reason. The canine teeth are almost instantly driven through the lung under the wing.

Doulton Potteries.—Sir Henry Doulton, head of the Lambeth potteries, whose death, November 17, 1897, has been recorded in the Monthly, preferred devoting himself to the factory to engaging in the study of a learned profession for which his parents intended him, and himself did much of the largest work produced there in the earlier days of his connection with it. As the factory was enlarged, it made drain pipes, vessels and appliances of stoneware for chemical and other similar uses, for which it gained prizes at the great exhibitions of 1851 and 1862; ale pots and mugs of traditional and original designs; terra-cotta vases; and first exhibited articles of higher artistic merit at Paris in 1867. It showed a magnificent collection at Vienna in 1873, and its exhibit at Philadelphia in 1876 was one of the marked features of our Centennial. The chief styles of its work are the ornamental salt-glazed stoneware known as Doulton ware, and the underglaze-painted earthenware called "Lambeth faïence." Sir George Birdwood ascribes as the great merit of Sir Henry's life work his adherence to the two principles of making, as far as possible, every piece intended for decoration on the wheel, and of giving the utmost scope to the designer into whose hands the piece fell for ornamentation. Four hundred designers, mostly women, and some of them real artists, are engaged at the potteries, and each has her way and signs her name to her work; so that "Sir Henry Doulton succeeded in creating a most prolific school, or rather several schools, of English pottery, the influence of which has been felt in the revival of the ceramic arts in all the countries of the Old World"—where they had been demoralized by the use of machinery; and through the influence of his example, working since 1871, the United Kingdom now produces "the most artistic commercial pottery of any country in the world."

MINOR PARAGRAPHS.

A little over a year ago Professor Fraser published the results of some researches which showed that the bile of several animals possessed antidotal properties against serpents' venom, and against the toxines of such diseases as diphtheria and tetanus, and that the bile of venomous serpents is an antidote to their venom. The results from an extension of these first experiments have been recently published in the British Medical Journal. The most important conclusions are as follows: The bile of venomous serpents is the most powerful antidote to venom,

and is closely followed in efficiency by the bile of innocuous serpents. Regarding the antidotal power of bile on the toxines of disease, Professor Fraser found that the bile of venomous serpents had more antidotal power than that of the majority of the other animals examined. It is curious that among the non-venomous animals the rabbit's bile is the most powerful in antidotal properties.

Three ways are mentioned by Prof. W. A. Herdman in which disease may be communicated through oysters to the consumer; viz., by the presence in the animal of inorganic, usually metallic, poison; or of organic poison; or of a pathological organism or definite disease germ. From experiments in the inoculation and disinfection of oysters, it was found that all traces of these organisms could be removed by proper washing. Good currents passing the beds are an important factor in keeping the oyster healthy, and make it possible for the animal to absorb large quantities of sewage and dispose of it. The effect of this is to purify the water; but in the sifting process, while the sewage is passing through, the animal retains disease germs, and may pass them on to the consumer. Oysters should therefore be given an opportunity to purify themselves, as is done in France, where they are kept for a time in clean tanks before being sent to market. Oysters may be effectively washed in fresh water. Sea water is unfavorable to disease germs. Greenness in oysters is caused by food administered to improve their quality; by the presence of copper; and in some American oysters by an inflamed condition of the mantle. Green spots are also produced by wandering cells getting under the epithelium. These cells are loaded with granules which give a copper reaction.

The most interesting result of the massacre and sack of Benin, the Saturday Review says, was the capture of a large series of brass plaques, statuettes, box lids, pipes, etc., which have been brought to England. The various articles are all castings, and their elaborate ornamentation bespeaks for their makers great skill in metal working. Most African tribes have smiths who hammer pieces of brass rod and wire into simple ornaments; but these Benin brasses represent a stage of metal working far more advanced than anything recorded for the native races of Africa. Nothing like them is being made by any negro race at present, and nothing is known that can be regarded as a precursor of them. A statuette in the Liverpool Museum of a negro holding a flint gun fixes their date as not earlier than about 1630. In trying to account for them, many think they were due to the influence of some comparatively advanced tribe that reached Benin from the central Soudan and brought with them a knowledge of brass work derived from early, possibly Egyptian, sources; and others attribute the work to some prisoner

or trader who lived at Benin in the seventeenth century.

NOTES.

The Committee of the British Association on Meteorological Photography reported that the result of their determinations of the heights of clouds showed the existence of greater altitudes in hot weather under thunderstorm conditions, when clouds may occur at five or six different levels, extending as high as ninety thousand feet. A rise of cloud takes place in hot weather, also during the morning and early afternoons, while the lowest altitudes are found during cyclones.

M. Maige, by varying the condition of exposure of plants to light, and keeping flowering branches in the dark, has succeeded in transforming the latter into sterile creeping or climbing branches. Inversely, he has been able, by means of the localized action of light, to transform creeping or climbing into flowering branches. These results were obtained at the vegetable biological laboratory of Fontainebleau.

F. L. Washburn, of the State University of Oregon, reports that the condition of the Eastern oysters introduced to the Oregon coast waters two years ago leaves nothing to be desired. The specimens have withstood two winters successfully, and have made phenomenal growth, "far exceeding what they would have made in the same time in their native waters. Further, they spawned." The experiments in artificial fertilization were not so successful. The spawn suffer from the serious difficulties of sudden variations in the temperature and salinity of the water resulting from the change of tide and strong winds. It is hoped that better conditions may be found at Yaquina Bay.

The population of Egypt has been gradually increasing during the past hundred years. It is stated to have been about two and a half million in 1800, and is now estimated at nearly ten million. There are about 112,000 foreigners, of whom 38,000 are Greeks; the remainder being chiefly Italians, 24,000; English, 19,000; French, 14,000; Austrians, 7,000; Russians, 3,000; and Persians and Germans, about 1,000 each. Only about five per cent of the population can read and write, and nearly two thirds are without any trade or profession.

Our record of deaths among men known in science includes the names of Dr. Henriques de Castro, a Dutch archæologist of Portuguese descent, member of many learned societies of the Netherlands; John Eliza de Vry, of the Netherlands, one of the chief authorities on the chemistry and pharmacy of the cinchona

alkaloids, at The Hague, July 30th, in the eighty-sixth year of his age; Dr. Eugenio Bettoni, director of the Fisheries Station at Brescia, Italy, August 5th, aged fifty-three years; Professor Arzruni, mineralogist in the Polytechnic Institute at Aix; Heinrich Theodor Richter, director of the School of Mines at Freiberg, Saxony; Dr. J. Crocq, professor of pathology in the University of Brussels; Dr. C. G. Gibelli, professor of botany and director of the Botanical Institute at Turin; Don Francisco Coello de Portugal, president of the Geographical Society of Madrid, and author of an atlas of Spain and its colonies; Dr. B. Kotula, author of Researches on the Distribution of Plants; Surgeon Major J. E. T. Aitchison, a distinguished botanist, particularly in the botany of India, and author of numerous papers on the subject, September 30th, in his sixty-fourth year; M. Thomas Frédéric Moreau, a French archæologist, author of a collection of Gallic, Gallo-Roman, and Merovingian antiquities, in his one hundred and first year; M. Gabriel de Mortillet, the eminent French anthropologist, in Paris, November 4th, aged sixty-seven years; Sir George Smyth Baden Powell, political economist, aged fifty-one years; Sir John Fowler, engineer in chief of the Forth Bridge, aged eighty-one years; Dr. James I. Peck, assistant professor of biology in Williams College, and assistant director of the Biological Laboratory at Woods Hole; George Vestal, professor of agriculture and horticulture at the New Mexico Agricultural College, October 24th, aged forty-one years; Dr. W. Kochs, docent for physiology at Bonn; M. J. V. Barbier, a distinguished French geographer; M. N. J. Raffard, an eminent French mechanical engineer, author of many valuable inventions; Latimer Clark, F. R. S., an eminent English electrician, one of the founders and a past president of the Institution of Electrical Engineers, whose name is associated with the history of electric telegraphy and with many inventions, and author of several books that are standard with the profession, at Kensington, London, October 30th, in his seventy-sixth year; Count Michele Stefano de Rossi, a distinguished Italian seismologist; M. de Meritens, a French electrical engineer, inventor of one of the first practical dynamos, and of other valuable electrical apparatus, aged sixty-five years.

FOOTNOTES:

[1] In its primary American sense the word *squatter* denotes the backwoodsman described in the foregoing paragraph. In its secondary Australian sense it means the large landholder now described.

[2] See an instructive article by Mr. Edward Eggleston, Social Conditions in the Colonies. Century Magazine, 1884, pp. 849, 850.

[3] Eggleston, *op. cit.*, p. 850.

[4] Eggleston, *op. cit.*, p. 858.

[5] In order to obtain the effects described in the various illustrations it is necessary in several cases to regard the figures for a considerable time and with close attention. The reader is requested not to give up in case the first attempt to secure the effect is not successful, but to continue the effort for a reasonable period. Individuals differ considerably in the readiness with which they obtain such effects; in some cases, such devices as holding the diagrams inverted or at an angle or viewing them with the eyes half closed are helpful.

[6] It is fortunate that Mr. Wells had practically completed his essays on taxation before death put an end to his activity. The manuscript of two chapters was found among his papers—one on the Best Methods of Taxation, and the other on the Law of the Diffusion of Taxes, begun in this number. The first manuscript has some pages missing, and it has been thought best to postpone its publication, in the hope that the missing pages may be found. It is evident that the last touches were yet to be put upon the chapter on the diffusion of taxes—a chapter that was to sum up the theory of taxation developed by the writer. So much of that summary is contained in it as to make the meaning of Mr. Wells unmistakable, and its publication is further amply justified by the number of practical illustrations and happy application of theory to fact, in the selection and explanation of which the author excelled. The entire series, which has been running in the Popular Science Monthly for more than three years, will now be collected in a volume—a worthy memorial to one whose powers of popular exposition of abstract problems placed him among the first of economists in the United States.

[7] On the Shifting and Incidence of Taxation, by Prof. Edwin R. Seligman, 1892.

[8] The assertion would not be warranted that the masses of New York were wholly unanimous in condemning Tweed, for a portion of them were undoubtedly well content with the situation. He had curried favor with the very poor and ignorant by distributing coal and flour, and making ostentatious presents of money; and these "charities" are remembered to this day in the poorer parts of New York city, and Tweed is esteemed by many as the victim of injustice, and a man who suffered because he was the friend of the people.

[9] Of the net ordinary receipts of the Federal Government ($385,819,000) in 1893, only about $12,000,000 was derived from sources that could not be regarded as taxes, and were mainly receipts from the sales and surveys of public and Indian lands ($4,120,000) and of other Government property.

[10] In 1897 the merchant tailors of the United States, who ought to know something about the incidence of a custom tax on imported clothing, united in a petition to Congress asking that Americans returning from Europe be permitted to introduce only two suits of foreign-made clothes free of duty; and in support of their request they comment as follows on a ruling of the Treasury in respect to this matter: "Under this ruling it was possible to enter free of duty vast quantities of foreign-made garments which had never been actually in use, and which were so imported solely because there exists a relative difference of at least fifty per cent in values between the cost of made-up garments in the United States and Europe, thus saving to the purchaser of garments abroad one half of their actual value upon arrival within the United States duty free." But if the foreigner who made and sold the goods in question was liable to pay the duty on dutiable clothing, and attended to his duty, there would be no profit to the returning tourist in importing clothing free of duty. It is further evident also that American tailors agree in opinion with Alexander Hamilton that the consumers of imported articles pay the customs taxes.

The records of the commercial relations between the United States and Canada are exceedingly instructive on this matter. They all show that for the products which the Canadian sends to the United States, and on which somebody pays the duty, he receives exactly the same price as for those products which he sends to England, on which nobody pays any duty. This experience is exactly the same as that of the farmers of the Northwestern States of the Federal Union, who usually get the same price for their wheat furnished to a Minnesota flour mill, or for shipment to free-trade England, as to countries like France and Germany, where heavy duties are assessed upon its import. The term "usually" is employed, for producers in the United States and Canada alike do not always get as large a price for the articles they export as for the same articles they sell to their fellow-countrymen. Again, if it be true, as the advocates of extreme protection assert, that the foreign exporter and not the consumer pays the duties on goods sent by him for sale in this country, how does it happen that it is not true concerning the farm produce and live stock exported from Canada? And why should American farmers be exempt from this rule in sending their grain to Europe? Has anybody ever known of England buying American products any cheaper in New York than France or Germany, and is it not also true that the French or German or Italian consumer usually pays at least the amount of the duty levied by his Government more for American products than his English competitor has, whose imports are subjected to no duty? During the period from 1854 to 1866 there was, under the reciprocity treaty, practically free trade between Canada and the United States in live stock, wool, barley, rye, peas, oats, and other farm products, while subsequent to 1866, when the reciprocity treaty had been repealed, duties were imposed on all these articles on their import from Canada into the United States. During the first period Canadian horses, for example, sold under free trade for shipment to the United States at from sixty-five to eighty-five dollars each, while during the years next subsequent to 1866 the value of the Canadian horses imported into the United States was returned at from ninety-two to one hundred and four dollars each; thus showing that the United States tariff did not force the Canadian horse breeders to lower their prices in order to compensate American purchasers for the duties exacted. And as regards the other products mentioned, the official data show that in no case did the imposition of duties under the United States tariff reduce the prices paid by American purchasers to the Canadian farmers for their products. These are very commonplace, very familiar, and very convincing facts which ought to silence all this talk about the foreign exporter or anybody else but the consumer paying the duty; but it is not at all probable that they will.

[11] 1877, p. 214.

[12] 1861 b, pp. 227 and 331.

[13] Glück, 1896 a. Jacobs, 1890, p. 82, did not find a trace of it in the Sephardim congregation in London. See Andree, 1878, in this connection.

[14] The cephalic index by which we measure the head-form is merely the breadth of the head in percentage of its length from front to back. The index rises as the head becomes relatively more broad.

[15] Verneau, 1881 a, p. 500.

[16] Pruner Bey, 65 b; Gillebert d'Hercourt, 1868, p. 9; and especially Collignon, 1887 a, pp. 326-339; Bertholon, 1892, p. 41; also Collignon, 1896 b.

[17] Eliséev, 1883.

[18] Bertholon, 1892, p. 43; Sergi, 1897 a, chapter i, and even more recently Fouquet, 1896 and 1897, on the basis of De Morgan's discoveries.

[19] Compare Brinton, 1890 a, p. 132, and 1890 b, for interesting linguistic data on the Semites.

[20] 1877, pp. 88-90; 1885, p. 84.

[21] Centralblatt für Anthropologie, vol. iii, p. 66.

[22] Virchow, 1886 b, p. 364; Schimmer, 1884, p. xxiii.

[23] Weissenberg, 1895, p. 567, finds brunettes twice as frequent among the south Russian Jewesses as among the men.

[24] 1886 a, p. xxxii.

[25] 1895, p. 563.

[26] Recherches anthropologiques dans l'Asie Occidentale (Archives du Museum d'histoire naturelle, Lyons, vol. vi, 1895).

[27] 1886 a, p. xxviii.

[28] Sommier, 1887, reprint, p. 116. Cf. Zograf, 1896, p. 50, on crania from the sixteenth century in Moscow.

[29] Congrès int. des sciences géographiques, Paris, 1875, p. 268.

[30] Livi, 1896 a, pp. 137 and 146.

[31] Beiträge zur Anth. Bayerns, vol. ii, 1879, p. 75.

[32] Africa, Antropologia della stirpe Camitica, Torino, 1897, p. 263.

[33] An address delivered at the Royal College of Science on October 6, 1898.

[34] Greek Geometry from Thales to Euclid, p. 2. Allman.

[35] Inferno, canto iv, p. 130 *et seq.*

[36] Subjects of Social Welfare, p. 206.

[37] History of the English People, vol. i, p. 198.

[38] See Histoire de l'Université de Paris. Crévier, 1791, *passim*.

[39] Enumerated in the following middle-age Latin verse:

"Lingua, tropus, ratio, numerus, tonus, angulus, astra."

[40] Universities of Europe in the Middle Ages, by Rashdall, vol. ii, p. 344.

[41] William Gilbert, of Colchester, on the Magnet. Mittelag, p. x.

[42] Novum Organum, vol. 1, p. 70. Fowler's edition, p. 255.

[43] Schools and Universities on the Continent, p. 291.

[44] University Education in England, France, and Germany, by Sir Rowland Blennerhassett, p. 25.

[45] See the article on Courses of Study in the Elementary Schools of the United States, by T. R. Crosswell, Pedagogical Seminary, April, 1897.

[46] An address delivered before the Richmond County (Georgia) Agricultural Society, on February 19, 1898.

[47] United States Department of Agriculture. Farmers' Bulletin, No. 48.

[48] Leguminous Plants for Green Manuring and for Feeding. E. W. Allen, Ph. D. United States Department of Agriculture. Farmers' Bulletin, No. 16.

[49] "Les enfans gâtés réussissent toujours."

[50] The Philippine Islands and their People. A Record of Personal Observation and Experiences, with a Short Summary of the More Important Facts in the History of the Archipelago. By Dean C. Worcester. New York: The Macmillan Company. Pp. 529. Price, $4.

[51] Wild Animals I have Known, and 200 Drawings. By Ernest Seton Thompson. New York: Charles Scribner's Sons. Pp. 358. Price, $2.

[52] Corona and Coronet: Being the Narrative of the Amherst Eclipse Expedition to Japan, in Mr. James's Schooner Yacht Coronet, to observe the Sun's Total Obscuration, August 9, 1896. By Mabel Loomis Todd. Boston and New York: Houghton, Mifflin & Co. Pp. 383. Price, $2.50.

[53] Revised Text-Book of Geology. By James D. Dana, LL. D. Fifth edition, revised and enlarged. Edited by William North Rice. American Book Company. Pp. 482.

[54] Familiar Life in Field and Forest. The Animals, Birds, Frogs, and Salamanders. By F. Schuyler Mathews. New York: D. Appleton and Company. Pp. 284. Price, $1.75.

[55] A Short Manual of Analytical Chemistry, Qualitative and Quantitative, Inorganic and Organic. By John Muter. Second American edition. Illustrated. Adapted from the eighth British edition. Philadelphia: E. Blakiston, Son & Co. Pp. 228. Price, $1.25.

[56] Lectures on the Geometry of Position. By Theodor R. Reye. Translated and edited by Thomas F. Halgate. New York: The Macmillan Company. Pp. 148. Price, $2.25.

[57] Introduction to the Study of North American Archæology. By Prof. Cyrus Thomas. Cincinnati: The Robert Clarke Company. Pp. 391.

[58] The Art of Taxidermy. By John Rowley. New York: D. Appleton and Company. Pp. 244. Price, $2.

[59] The Storage Battery. A Practical Treatise on the Construction, Theory, and Use of Secondary Batteries. By Augustus Treadwell. New York: The Macmillan Company. Pp. 257. Price, $1.75.

[60] Natural Advanced Geography. By Jacques W. Redway and Russell Hinman. American Book Company. Pp. 100.

[61] Differential and Integral Calculus. For Technical Schools and Colleges. By R. A. Lambert. New York: The Macmillan Company. Pp. 245. Price, $1.50.

Transcriber's Notes:

Obvious printer's errors have been repaired, other inconsistent spellings have been kept.

Illustrations were relocated to correspond to their references in the text.

Foundation's web site and official page at www.gutenberg.org/contact

For additional contact information:
    Dr. Gregory B. Newby
    Chief Executive and Director
    gbnewby@pglaf.org

Section 4. Information about Donations to the Project Gutenberg Literary Archive Foundation

Project Gutenberg-tm depends upon and cannot survive without wide spread public support and donations to carry out its mission of increasing the number of public domain and licensed works that can be freely distributed in machine readable form accessible by the widest array of equipment including outdated equipment. Many small donations ($1 to $5,000) are particularly important to maintaining tax exempt status with the IRS.

The Foundation is committed to complying with the laws regulating charities and charitable donations in all 50 states of the United States. Compliance requirements are not uniform and it takes a considerable effort, much paperwork and many fees to meet and keep up with these requirements. We do not solicit donations in locations where we have not received written confirmation of compliance. To SEND DONATIONS or determine the status of compliance for any particular state visit www.gutenberg.org/donate

While we cannot and do not solicit contributions from states where we have not met the solicitation requirements, we know of no prohibition against accepting unsolicited donations from donors in such states who approach us with offers to donate.

International donations are gratefully accepted, but we cannot make any statements concerning tax treatment of donations received from outside the United States. U.S. laws alone swamp our small staff.

Please check the Project Gutenberg Web pages for current donation methods and addresses. Donations are accepted in a number of other ways including checks, online payments and credit card donations. To donate, please visit: www.gutenberg.org/donate

Section 5. General Information About Project Gutenberg-tm electronic works.

Professor Michael S. Hart was the originator of the Project Gutenberg-tm concept of a library of electronic works that could be freely shared with anyone. For forty years, he produced and distributed Project Gutenberg-tm eBooks with only a loose network of volunteer support.

Project Gutenberg-tm eBooks are often created from several printed editions, all of which are confirmed as Public Domain in the U.S. unless a copyright notice is included. Thus, we do not necessarily keep eBooks in compliance with any particular paper edition.

Most people start at our Web site which has the main PG search facility:

    www.gutenberg.org

This Web site includes information about Project Gutenberg-tm, including how to make donations to the Project Gutenberg Literary Archive Foundation, how to help produce our new eBooks, and how to subscribe to our email newsletter to hear about new eBooks.